CALTRANS
HYDRAULIC APPLICATION STUDY
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The primary objective of the Caltrans Hydraulic Application Study (CHAS) was to assess the performance of seven hydraulically-applied erosion control products applied to soil plots at the San Diego State University Soil Erosion Research Laboratory (SDSU/SERL). A secondary project goal was to use the erosion control performance and water quality data generated by the study to make statewide recommendations on specification and use of the hydraulic practices tested.

CHAS examined the erosion potential of two (2) distinctly different, custom-blended soils characteristic of two soils typically found on fill slopes within District 7 (Los Angeles). Seven (7) erosion control products were hydraulically applied to the two different soil types. The erosion control products tested included Earth Guard®, Soil Sement®, Airtrol®, Ultra Tack®, Chemco®, Tacking Agent III®, Topcoat®.

Each hydraulic application was subjected to two (2) sequential simulated storm events, each representing a 10-year storm as predicted for the Los Angeles Basin. The hydraulic soil stabilizers were compared using a variety of criteria, including soil loss, runoff, and 24 water quality measurements: pH, TSS, BOD, COD, TOC, NO_3, TKN, P, dissolved Al, As, Ba, Ca, Cd, Cr, Cu, Fe, Hg, Li, Mg, Ni, Pb, TI, V, Zn.

This experiment had a randomized block design, with eight soil treatments (seven products and a bare soil) applied to each of four soil conditions (fine and course soils, storms 1 and 2). Each response variable, e.g., soil loss, runoff, and 24 water quality variables was considered separately. A non-parametric randomized block analysis, the Friedman test, was performed for each variable.

Post-hoc multiple comparisons were done to determine the actual differences between products for eight response variables displayed significant differences between the products and bare soil. Airtrol®, Earth Guard®, and Ultra Tack® had the lowest pH, TSS, P, and lowest amount of soil loss. Soil loss, pH, TSS and P were significantly lower than bare soil and significantly better than the other products for Airtrol®, Earth Guard®, and Ultra Tack®. Chemco® and Topcoat® also had low phosphorous. However, TOC, Mg, Ca were significantly higher for Airtrol®, Earth Guard®, and Ultra Tack® than for bare soil. Additionally, BOD for Ultra Tack® was significantly higher than for bare soil.

1.1 PROJECT DESCRIPTION AND OBJECTIVES OF STUDY

The purpose of the California State Department of Transportation (Caltrans) Hydraulic Application Study (CHAS) was to examine the data from expanded indoor laboratory testing at the San Diego State University Soil Erosion Research Laboratory (SDSU/SERL) conducted as part of the Laboratory Correlation Study (LCS) (Appendix E).

The SDSU/SERL indoor soil test bed and rainfall simulator has been used extensively to examine the performance of various types of erosion control best management practices (BMPs). Over the course of the two-year Caltrans District 7 Erosion Control Pilot Study (ECPS), fourteen different BMPs were installed on one type of soil, a clayey sand. These materials were subjected to a wide range of simulated storm events (e.g. 5-year, 10-year, and 50-year intensities) to evaluate their erosion control effectiveness and impact on water quality.

The CHAS examined the erosion potential of two (2) distinctly different, custom-blended soils characteristic of two soils typically found on fill slopes within District 7 (Los Angeles). Seven (7) erosion control products were hydraulically applied to the two different soil types. The erosion control products tested included:

Earth Guard®
Soil Sement®
Airtrol®
Ultra Tack®
Chemco®
Tacking Agent III®
Topcoat®.

Each hydraulic application was subjected to two (2) consecutive storm events, each simulating a 10-year storm as predicted for the Los Angeles Basin. The SDSU test method provides a comparative evaluation of temporary erosion control practices to baseline bare soil conditions under controlled and documented conditions. The SDSU test method is in general conformance with the outlined methods and scope of ASTM D6459, Standard Test Method for Determination of Erosion Control Blanket (ECB) Performance in Protecting Hillslopes from Rainfall Erosion.

The indoor tests at the SDSU/SERL attempted to establish relative performance of the hydraulically applied erosion control products by measuring soil erosion rate, runoff volume, and sediment loss. Sampling also included collection of flow-weighted composites for water quality analysis. Results from the water quality analysis were examined to compare with data obtained from the bare soil controls. One of the project goals was to make statewide recommendations about use of specific erosion control products based upon erosion control effectiveness and water quality impacts.

2.1 TEST FACILITY

SDSU/SERL integrates beneficial features from some of the primary soil erosion research facilities in the United States. Funding for the facility was provided by Caltrans as part of a 1998-2000 Erosion-Control Pilot Study CTSW-RT-.00-012 Actual modification of Industrial Technology Building Room #103 and construction of the soil test bed was carried out by the SDSU Physical Plant (Figure 1).

In designing the SDSU laboratory, members of the Caltrans pilot study team studied the physical layout, testing protocols, and past research activities of the following soil-erosion laboratories:

- Utah Water Research Laboratory (UWRL) at Utah State University, Logan, Utah
- USDA-Agricultural Research Service National Soil Erosion Research Laboratory (NSERL) at Purdue University, West Lafayette, Indiana
- Texas DOT/Texas Transportation Institute (TTI) Hydraulics and Erosion Control Laboratory at Texas A&M, College Station, Texas

The SDSU laboratory is used primarily to provide comparative evaluations of temporary erosion-control practices (e.g., surface mulches, soil-roughening procedures, and liquid soil stabilizers) to baseline, bare-soil conditions under controlled, reproducible, and documented conditions.

2.2 NORTON LADDER RAINFALL SIMULATOR

The rainfall simulation device selected for the SDSU Soil Erosion Laboratory was the Norton Ladder Rainfall Simulator, developed at the USDA-ARS National Soil Erosion Research Laboratory Figure 2). This apparatus is reasonably inexpensive, easily transported and operated, and has been used worldwide.

For testing in the indoor laboratory, four multiple simulators were installed in parallel above the soil test bed to uniformly apply precipitation over the entire test plot area (Figure 3).

2.2.1 Physical Characteristics

The basic unit of the simulator was an aluminum frame 5.3 meters (17 feet) long, 0.32 meters (12 inches) wide, and 0.25 meters (10 inches) deep. Each frame was a self-contained unit that includes nozzles, piping, an oscillating mechanism, and a drive motor (Figure 4).

The nozzle formerly used for the Norton simulator was the Spraying Systems Veejet 80100 nozzle (Figure 5), and the nozzles were spaced 1.1 meters (3.6 feet) apart. For uniform intensity across the plot, the center of spray patterns from two laterally adjacent nozzles met at the plot surface. This provided a 2.25-mm (.09 in) median drop size, a nozzle exit velocity of 6.8 meters per second (22.3 feet per second), and a spherical drop.

The impact velocities of almost all drops from the Veejet nozzle were nearly equal to the impact velocities of those from natural rainstorms when the nozzle was at least 2.4 meters (7.9 feet) above the soil surface. For this reason, the rainfall simulators used in the SDSU Soil Erosion Laboratory were installed so that the nozzles were at least 2.5 meters (8.2 feet) above the soil surface. Rainfall intensity can be changed instantaneously with the simulator in operation, and the maximum intensity produced would be 135 mm/hr (5.3 in/hr).

2.2.2 Design of Simulated Rainfall

Before testing, the Norton ladder-type simulators were placed into position above the soil test bed. Calibration was achieved by conducting rainfall tests and measuring rainfall volumes in collection devices (Figure 6) placed at precise intervals within the 2 meter by 8 meter (6.5 foot by 26 foot) test plot. A full range of rainfall intensities can be achieved by adjusting one or both of the following parameters:

- The number of sweeps per minute (spm) of the spray nozzles, ranging from 25 to 125 spm (Figure 7).
- Adjusting the water pressure within the supply system. Each simulator has a system of valves that allows internal water pressure to be adjusted from 2 to 6psi. Gauges atop each simulator allow for accurate, manual adjustment (Figure 8).

Simulated rainstorm events used for most of the current testing at the SDSU/SERL have an initial period (Part 1) of low-intensity rainfall, followed by a period (Part 2) of relatively high-intensity rainfall, and ending with a period (Part 3) of relatively low-intensity rainfall.

2.3 SOIL TEST BED

The soil test bed is a 3-meter-wide by 10-meter-long (323 square feet) metal frame that rests on a series of pivots at the lower end of the bed, and which is supported by two hydraulic cylinders near the upper end of the bed (Figure 9). These telescopic cylinders extend to tilt the test bed from its horizontal position to a maximum 2H:1V slope gradient (Figure 10). As a safety precaution, stationary steel support posts are placed beneath the bed when it is raised for rainfall simulations.

The test bed is designed to support a 30.5-cm (1 foot) depth of soil, which is sufficient to allow placement and compaction of soil and the application of various surface erosion-control practices to evaluate their effect on erosion rates.

The sides and ends of the soil test bed are constructed of steel frame-supported 1.0-cm-thick (0.4 in) Plexiglas (Figure 11) that allows ambient light onto the soil surface and facilitates viewing of the effects of rainfall impact and runoff. The total usable surface area of the soil bed is 3 meters (10 feet) wide by 10 meters (33 feet) long, but during testing, only a portion of the treated bed--2 meters wide (6.5 feet) by 8 meters long (26 feet) long--is generally delineated for evaluation by the use of plastic edging (Figure 12). Runoff and sediment are collected at the toe of the slope by a metal flume (Figure 13). Drainage grates have been installed in the floor underneath and at the front of the soil bed, and all runoff not collected is directed to a sanitary sewer.

2.4 HYDRAULIC LIFT SYSTEM

The soil test bed was designed to be lifted hydraulically to the desired slope inclination for testing. Two five-stage, single-acting, telescopic cylinders are positioned approximately 3.0 meters (10 feet) from the top of test bed. The cylinders, which weigh 230 kilograms (505 pounds), each, have a 20.3-cm (8-inch) diameter as the largest moving stage.

The complete hydraulic system consists of the cylinders, a 227-liter (60-gallon) hydraulic fluid reservoir, a 114-lpm (30-gpm) hydraulic pump, and a 50-hp electric motor with motor starter (Figure 14). Also included are a suction strainer, return oil filter, pressure-relief valve, and directional-control valve.

2.5 SEDIMENT COLLECTION SYSTEM

Water and soil runoff from the test bed is collected by plastic edging, flume, and collection containers (Figure 15). The components of the sediment collection system on the test bed are installed before each rainfall simulation. For most erosion-control treatment evaluations, the plastic edging is installed before application of the erosion-control treatment.

2.6 WATER TREATMENT AND STORAGE

To obtain accurate results from the rainfall simulation/erosion-rate evaluations, the municipal water supply is treated by reverse osmosis and softened to remove minerals. This treatment process produces "softer" water that is more similar in quality to natural rainfall. Using municipal water without treatment would cause a decrease in sediment load because minerals in the water serve to decrease erosion.

2.6.1 Water Treatment System

The water-treatment system (Figure 16) consists of a reverse-osmosis unit, preceded by one activated carbon vessel and two softening vessels arranged in series (i.e., carbon/softener/softener). The system, which is capable of producing 1,140 to 2,270 liters per day (300 to 600 gallons per day), also, includes a pre-filter to remove particulates greater than five microns in size that may escape the service vessels. The system is serviced monthly by a local U.S. Filter representative.

Delivery of water to the rainfall simulators positioned above the soil test bed is by a pump attached to hard plumbing and flexible hoses. A key aspect of the Norton design is that unused water from within the simulators is returned to the holding tank and available for reuse (Figure 17). Flexible plumbing is installed to accommodate this return flow.

2.6.2 Treated Water Storage

Treated water is stored in a 3,785–liter (1,000-gallon) polyethylene storage tank for use in the laboratory simulations (Figure 18).

3.1 REVIEW OF TESTING PROCEDURES FOR CHAS

A review of current laboratory procedures was performed to evaluate adequacy and appropriateness for the Caltrans Hydraulic Application Study (CHAS). The detailed procedures for soil selection, soil placement in the test bed, erosion-control treatment application, sediment and runoff collection, and operation of the rainfall simulation equipment can be found in the *Laboratory Manual* CTSW-RT-.00-018. In brief, the procedures relative to the CHAS may be separated into six components, as follows:

1. Sizing of test plots
2. Selection of soil type for evaluation
3. Placement of soil material in test bed
4. Test bed preparation for erosion-control material testing
5. Mixing and application of test materials
6. Runoff and sedimentation collection and analysis procedures
7. Water-quality analysis procedures

3.2 SIZING OF TEST PLOTS

The runoff and sedimentation data from the CHAS 2 meter by 8 meter test plots is normalized and presented in terms of liters of water and/or kilograms of sediment per hectare. This data is then compared against normalized data from bare soil (control) plots for the two types of soil that were tested.

3.3 SELECTION OF SOIL TYPE

SDSU evaluated soil samples from District12 field sites to custom-blend two soils for testing at the Soil Erosion Research Laboratory. Once the soils were analyzed, orders for local custom-blending were issued to the supplier, Lakeside Land Company. Before delivery of the custom soil to the SDSU/SERL, soil samples from the supplier were evaluated against the required specifications. These specifications included particle size distribution analysis in accordance with ASTM Methods D2487 and D1140 and Atterburg Limits (liquid limits, plastic limits, and plasticity index) in accordance with ASTM Method D4318 (see Appendix B). The custom-blended soil was then transported to SDSU and stored inside the laboratory until it was placed in the test bed (Figure 19). The characteristics of the soils used in the CHAS study are presented in Table 3-1

Table 3-1
CHARACTERISTICS OF SOIL USED FOR
CALTRANS HYDRAULIC APPLICATION STUDY

	Soils From District 7 Test Sites		**Custom Soils for Testing**	
	(Soil A)	**(Soil B)**	**(Soil C)**	**(Soil D)**
U.S. Standard	*Olive Yellow*	*Light Olive Brown*	*Lab Soil*	*Mound Clay*
Sieves	*Silty Sand*	*Sandy Clay*	*Clayey Sand*	*Silty Clay*
2”	100	-	-	-
1.5”	96.5	-	-	-
1”	96	100	-	-
3/4”	95	99	-	-
3/8”	94	97	-	-
#4	91	95	93	98
#10	89	92	91	96
#20	85	87	-	-
#40	74	81.5	53	72
#60	57	76	14	62
#140	24	58	11	53
#200	21	55	6	50

3.4 PLACEMENT OF SOIL MATERIAL IN THE TEST BED

Detailed procedures are found in Appendix A. In general, however, the following bed preparation procedures were implemented before the beginning of the testing schedule:

1. Soil was moisturized, tilled, and hand compacted to uniform consistency (Figure 20).
2. Sand cone tests were conducted over random portions of the prepared bed for each new soil type (after it was installed) to determine relative compaction and moisture content of the soil (Figure 21).
3. These tests were conducted immediately after a new soil was introduced into the bed (i.e., coarse or fine).

The introduction of the Soil D (silty clay) into the bed necessitated removal of 30 centimeters (12 inches) of the existing Soil C (clayey sand) from the 2 meter by 8 meter portion of the test bed (Figure 22). Whenever a soil to be tested is changed, the new soil is placed in

10-centimeter (4-inch) lifts and compacted within the excavated portion (30 centimeters by 2 meters by 8 meters) of the bed (Figure 23).

3.5 BED PREPARATION FOR EROSION-CONTROL MATERIAL TESTING

The following bed-preparation procedures were implemented for the evaluation of the hydraulically applied soil stabilizers:

1. Before each new material test (i.e., hydraulically applied soil stabilizer), the soil test bed was placed in the horizontal (flat) position.
2. Wetted soil in the bed (from the previous testing) was removed to expose untested soil, and additional soil was added to replace the soil that was removed (Figure 24).
3. The new soil was moisturized, tilled, and hand compacted to uniform consistency (Figure 25).
4. Edging and flumes were installed to differentiate a 2 meter by 8 meter plot (Figure 26).
5. The selected surface treatment was applied (Figure 27) to each 2 meter by 8 meter plot in a manner consistent with actual field application rates (Table 3-2).
6. The hydraulically applied soil stabilizer was allowed to dry for 24 hours.
7. The test bed is raised to a 2H:1V slope before rainfall.
8. Rainfall (10 year-2 storm) is introduced and samples are collected (Event 1).
9. The bed is allowed to dry for 24 hours.
10. A second rainfall (10 year-2 storm) is introduced and samples are collected (Event 2).

3.6 MIXING AND APPLICATION OF TEST MATERIALS

Mixing the proper amount of hydraulic soil stabilizer, water, and mulch was accomplished using a Finn T-30 Hydroseeder (Figure 28). The actual amount of materials (e.g., the mixture ratios) is presented in Table 3-2.

Once the appropriate amount of materials was mixed in the hydroseeder (Figure 29), a rate of flow was determined by taking the average fill time for three 15-liter (4-gallon) buckets (Figure 30). Table 3-3 presents a formula that was developed for determining the time of application (Figure 31). Once the material was applied, it was allowed to dry for 24 hours before the first rain event (Figure 32).

Table 3-2
MIXTURES AND APPLICATION RATES FOR HYDRAULICALLY-APPLIED MATERIALS

Product	Suggested Application Rate	Mix Ratio	Application Rate for Test Plot*
Earth Guard® (fine graded soil)	6-7 gal product/acre	6 gal product 3,000 gal water	0.026 gal product 13.0 gal water
Earth Guard® (coarse graded soil)	1 gal product/ 0.1 acre 227.5 lbs mulch 300 gal water	1 gal product/ 0.1 acre 227.5 lbs mulch 300 gal water	0.04 gal product 9.1 lbs mulch 12 gal mulch
Soil Sement®	670 gal/acre	4:1 ratio water to product	2.68 gal product 10.72 gal water
Tacking Agent III®	80 lbs/acre	16 lbs product 500 gal water	0.293 lbs product 9.15 gal water
Airtrol®	5000 lbs/acre	1000 lbs product 300 lbs mulch 600 gal water	20 lbs product 6.67 lbs mulch 13.33 gal water
Ultra Tack®	25 lbs/acre	5 lbs product 325 lbs mulch 600 gal water	0.1 lbs product 6.5 lbs mulch 12 gal water
Chemco®	2 - 5 lbs/acre	5 oz product 400 gal of water	0.014 lbs product 17.92 gal water
Top Coat (Second Nature)	3500 lbs/acre	700 lbs product 1000 gal water	14 lbs product 10.72 gal water

* Based on 0.004-acre plot size

Table 3-3
FORMULA FOR DETERMINING APPLICATION TIME FOR HYDRAULIC PRACTICES

$$T = \frac{W_{hydro} \ x \ MAT_{subplot} \ x \ t_{avg}}{(15.14 \ liters) \ x \ MAT_{hydro}}$$

where:

W_{hydro}	=	volume of water added to the hydroseeder
$MAT_{subplot}$	=	weight of material to be applied to plot
t_{avg}	=	average time to fill a 15 liter (4 gal) bucket
MAT_{hydro}	=	weight of material added to hydroseeder

3.7 RUNOFF AND SEDIMENT COLLECTION AND ANALYSIS PROCEDURES

The procedures for collecting and analyzing runoff water and sediment from the laboratory plots were as follows:

- Runoff and sediment samples were collected in separate 35-gallon containers for Parts 1, 2, and 3 of each storm cycle (Figure 33).
- 500 grams of gypsum were added to aid in settling of sediment (Figure 34).
- The sample containers were allowed to settle overnight.
- The clear supernatant was decanted and the runoff volume recorded (Figure 35).
- A representative sample of the wet sediment was collected for moisture content analysis (Figure 36).

- Based on the calculated moisture content of this sample, the dry weight of the total sediment sample was calculated.
- Samples of wet sediment were weighed and then dried in an oven (Figure 37) to determine gross sediment discharge and erosion rate.

3.8 WATER QUALITY ANALYSIS AND PROCEDURES

3.8.1 Manual Sampling Procedures

Water samples were collected to measure the baseline water quality, determine what types of materials leach out of the hydraulic soil stabilizers, and measure the amount of sediment transported in the runoff. The water-quality analyses were conducted according to standard EPA methods.

For each erosion-control treatment, a grab sample of the runoff was collected from each of the three intensity/duration storm components of each test event for analysis (Figure 38). The volume of runoff collected from each of the three storm parts was proportional to the water applied during each storm part to simulate a flow-weighted composite sample (Figure 39). The volume collected for each storm part was as follows:

- Storm Part 1 – 0.5 liters (0.1 gallons), one sample at 15 minutes into the first part of the storm.
- Storm Part 2 – 4 liters (1 gallon), three samples at 10, 20, and 30 minutes into the second part of the storm.
- Storm Part 3 – 0.5 liters (0.1 gallons), one sample at 15 minutes into the third part of the storm.

The basic procedure for water-quality sampling was as follows:

- The sampler put on gloves and other protective gear.
- The sampler obtained a sample collection bottle.
- The sample bottle was inserted into the corner of the flow by hand.
- The sample bottle was filled and then removed by hand.
- The sample bottle was placed in an insulated cooler for transport to the analytical laboratory.

3.8.2 Gloves and Protective Gear

Surgical latex gloves were worn during sample collection to avoid contamination of the sample bottle. Additionally, the gloves provided protection from harmful materials that could be present in the runoff water. One set of gloves was used throughout each storm event. New gloves were used for each subsequent storm test.

3.8.3 Sample Bottle Insertion and Recovery

The sampler manually collected samples by dipping a sample bottle into the water stream running off the plot. To collect the sample, the sampler obtained a clean sample bottle and moved to the sample collection location at the lower end of the simulator bed. At the appropriate time, the sample bottle was placed in the center of the water stream flowing off the simulator bed. Once the bottle was filled to the appropriate (flow proportioned) volume, it was sealed and then placed in the insulated cooler for transport to the analytical laboratory.

3.8.4 Sample Bottles and Volumes

Commercially available, wide-mouth glass bottles were used for collecting the samples.

3.8.5 Chain of Custody

All water quality samples were accompanied by a standard chain of custody form - (Appendix D) The following information was included on the form: sample identification, sample analysis, sample date and time, as well as the names of all persons responsible for the sample.

3.8.6 Preservation

Samples were immediately placed in an insulated cooler following collection and transported to the analytical laboratory. All required preservatives were added to the sample containers by the analytical laboratory.

3.8.7 Holding-Time Limitations

Each water quality test has a specified period within which the analysis must be performed. This period is called the *holding time for analysis*. These times place restrictions upon the laboratory analysis; the analytical laboratory was aware of the allowable holding times.

3.8.8 Parameters

The analytical laboratory, combined the three samples collected from each test plot to create a flow-weighted composite sample for analysis for the following constituents:

- pH – EPA Method 150.1
- Biological Oxygen Demand (BOD) – EPA Method 405.1
- Chemical Oxygen Demand (COD) – EPA Method 410.4
- Sixteen dissolved Metals (dissolved Al, As, Ba, Cd, Ca, Cu, Cr, Fe, Pb, Li, Mg, Hg, Ni, Tm, V, Zn) – Atomic Absorption Spectrophotometry
- Total Organic Carbon (TOC) by TOC Analyzer – EPA Method 415.2
- Total Suspended Solids (TSS) – EPA Method 160.2
- Phosphorus – EPA Method 365.2
- Total Kjedahl Nitrogen (TKN) – EPA Method 351.4
- Nitrate + Nitrite Nitrogen – EPA Methods 353.3/354.1

3.8.9 Water Quality of Reverse Osmosis Treated Water

The SDSU laboratory's reverse osmosis treated water was also analyzed for the same constituents as the test runoff to establish the baseline water quality of the water being used for rainfall simulation.

3.8.10 Sampling for General Water Quality Indicators

Water samples were analyzed for general water-quality indicators, including pH, BOD, and COD. These analyses provided an indication of the relative acidity/basicity of the water, as well as an indication of the presence of substances that would require oxygen to break them down.

- **pH –** A 100-ml aliquot was obtained from the thoroughly mixed sample and poured into a plastic container containing no preservative. The sample was analyzed for pH using EPA Method 150.1. The analysis was conducted as soon as possible following preparation of the flow-weighted composite sample.
- **COD –** A 100-ml aliquot was obtained from the thoroughly mixed sample and poured into a plastic containing sufficient nitric acid to reduce the pH to below 2.0. The sample was analyzed for COD using EPA Method 410.4. The holding time for the analysis is two weeks, provided the sample is refrigerated.

- **BOD –** A 500-ml aliquot was obtained from the thoroughly mixed sample, poured into a plastic container, and sealed without headspace. The holding time for this analysis is 48 hours, provided the sample is refrigerated.

3.8.11 Sampling for Dissolved Metals

The dissolved metals were analyzed using atomic absorption spectrophotometry. The water sample was poured into two 1-liter, acid–washed, plastic containers containing sufficient nitric acid preservative to reduce the pH to below 2.0. Before analysis, the sample was sealed and filtered. The holding time for the analysis is two months.

3.8.12 Sampling for Total Organic Carbon

Samples to be analyzed for total organic carbon (TOC; EPA Method 415.2) using a TOC analyzer were poured into a 100-ml glass container and sealed without headspace. Each sample was preserved with sufficient nitric acid to reduce the pH to below 2.0. The holding time for the analysis is two weeks, providing the sample is refrigerated.

3.8.13 Sampling for Suspended Solids

Water samples were analyzed for TSS (EPA Method 160.2) to evaluate the erosion rate. A 200-ml aliquot was obtained from the thoroughly mixed sample and poured into 200-ml plastic containers without preservative and refrigerated.

4.1 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

The overall objective of the QA/QC program was to implement the procedures necessary to obtain consistent, high-quality data by laboratory measurement and analysis. Generally, data quality and representativeness were assured by following approved, standardized laboratory procedures established during the previous Soil Stabilization for Temporary Slopes Study (SSTS) and ECPS (CTSW-RT-00-012) studies. According to EPA guidelines, the data should be accurate, precise, and complete. Additionally, the data should have the characteristics of representativeness and comparability.

The representativeness of data was assured by following standardized measurement, sampling, and analytical procedures. Environmental measurements were made so that the results were representative of the media and the conditions being measured. A strict system of quality assurance and quality control was followed in all phases of the testing program, including sampling, laboratory analysis, and data reporting/validation.

4.2 LABORATORY QA/QC PROCEDURES

Laboratory QA/QA procedures were designed to verify that the methods used to measure the chemical constituents of interest 1) exhibit acceptable recoveries, 2) generate reproducible values, and 3) demonstrate that control samples do not contain levels of contaminants that would interfere with quantification of the constituents of concern.

Completeness of the data packages, adherence to holding times, temperature requirements, and evaluation of accuracy and precision are key components of a laboratory QA/QC program. These elements, and other described below, were checked for each laboratory report.

4.2.1 Completeness and Representativeness of the Data Package

The overall data package and individual lab reports were evaluated for completeness and representativeness of deliverables against the following criteria:

- Presence of lab reports for each sample sent
- Presence of results of all requested analyses in each lab report
- Presence of all applicable QA/QC results in each lab report
- Representative of the media and conditions being measured
- Representative of the method and instrument used

4.2.2 Holding Times

Sample collection to sample analysis holding times were calculated by computing the difference between the sample collection date and time (found on the chain-of-custody form) and the sample analysis date and time (as reported by the laboratory). Where applicable to the method, sample collection to sample extraction holding times were calculated by computing the difference between the sample collection dates and the sample preparation dates. Sample extraction to analysis holding times were calculated by computing the difference between the sample preparation dates and the sample analysis dates. Analyses that were not performed within holding-time limits were flagged and recorded in the QA/QC summary provided by the laboratory.

4.2.3 Temperature

Most analyses require that samples be kept cool for preservation. To meet this requirement, samples were placed in insulated coolers when transported to the analytical laboratory. Samples were confirmed to have met the temperature requirement at the time they were logged in at the lab.

4.3 TRAINING PROGRAM

During the SSTS (1999) and the District 7 ECPS (June 2000), workers at the SDSU/SERL participated in training sessions. Training included the proper operation and maintenance of the soil test bed, rainfall simulators, hydraulic lift devices, water-treatment system, and other laboratory equipment necessary to effect proper testing and collection of runoff and sediment samples. The focus of these training sessions was the safe use of equipment and the degree of diligence necessary to achieve consistency and accuracy of results.

Subsequent team meetings and instruction for the Caltrans Hydraulic Application Study (CHAS) included the following topics:

- Introduction to the project, including the goals and objectives of the study.
- Familiarization with the equipment and the importance of each device.
- Proper documentation and record keeping.
- Health and safety requirements.

Training at the laboratory facility consisted of the following activities and topics:

- Demonstrations of soil mixing and placement of soil in the test bed.
- Soil test methods for moisture content, dry density, and compaction.
- Operation of hydraulic lift system for the soil test bed.
- Operation of water treatment and supply system.
- Calibration, installation, and operation of rainfall simulators.
- Collection procedures for runoff and sediment.
- Regular servicing of equipment and recording activities in the Maintenance Log.
- Photo documentation.

4.4 OPERATION AND MAINTENANCE MANUAL

In conjunction with the training program, a manual was produced that covered the safe operation and maintenance of the equipment in the SDSU/SERL (2000), including the following:

- Rainfall simulators
- Soil test bed
- Hydraulic lift system
- Water treatment and supply system
- Soil-preparation equipment (tillers, compactors, etc.)
- Finn T-30 hydromulcher
- Analytical equipment (e.g., soil testing, scales, etc.)

The O & M Manual also included the standard operating procedures previously described.

4.5 VERIFICATION PROCEDURES

At the beginning of each test sequence, either the laboratory director or the assistant director observed the operation of each element of the testing protocol and provided any needed refinement or clarification to the established procedures. If unsafe, inaccurate, or inappropriate methods were used, the lab workers were retrained and monitored to ensure compliance.

5.1 RESULTS

The results and data of the Caltrans Hydraulic Application Study (CHAS 2002) are presented in terms of runoff (liters) and sediment loss (kilograms) for both the fine and coarse soils. Additionally, the results of water quality analysis are presented in Table 5-7.

Table 5-1 and 5-2 graphically represent the effect of the seven hydraulic practices on runoff, both for fine-grained and coarse-grained soils respectively. Table 5-3 provides the numerical percentage of reduction or increase in runoff compared to bare soil.

Table 5-1
Comparative Runoff from Seven Hydraulic Practices
For a Fine-Grained Soil

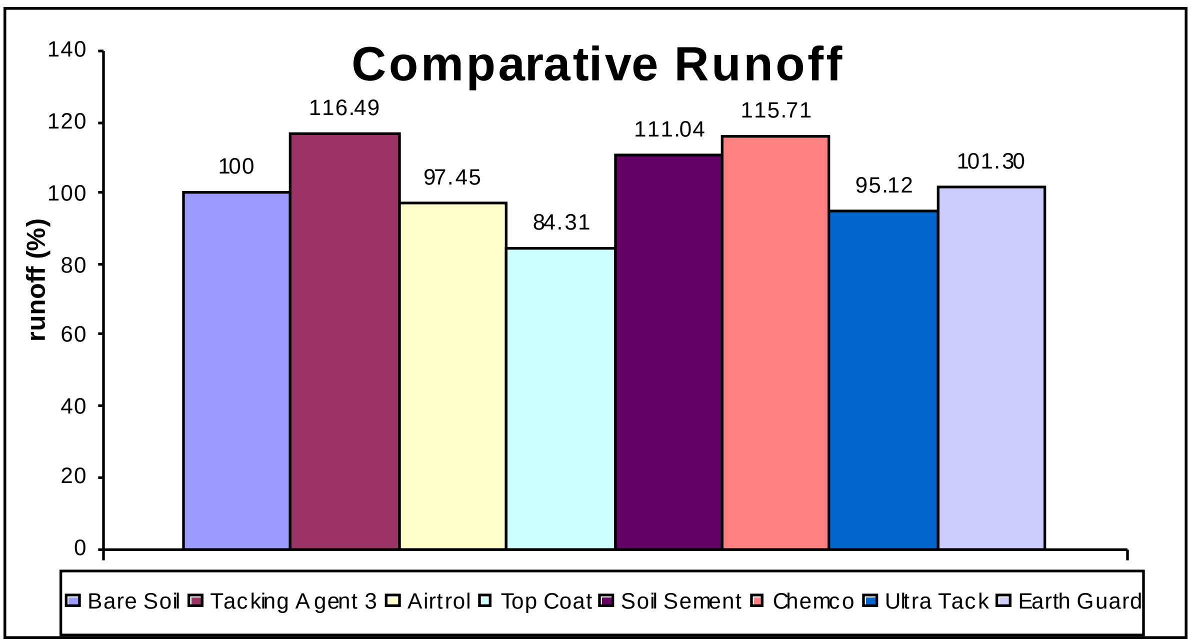

Table 5-2
Comparative Runoff from Seven Hydraulic Practices
For a Coarse-Grained Soil

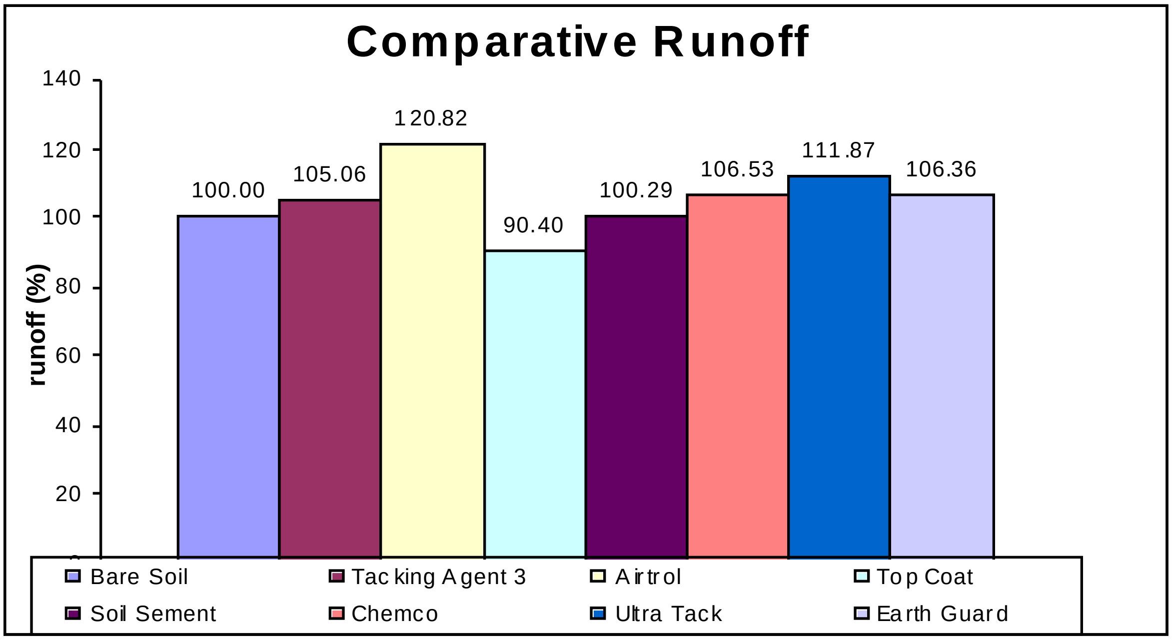

Table 5-3
A Comparison of Runoff Values for Seven Hydraulic Practices
For Fine-Grained Versus Coarse-Grained Soils

TREATMENT	FINE-GRAINED	COARSE-GRAINED
Bare soil	100%	100%
Tacking Agent III®	(+) 16.5%	(+) 5.1%
Airtrol®	(-) 2.5%	(+) 20.8%
Top Coat	(-) 15.7%	(-) 19.6%
Soil Sement®	(+) 11.0%	(+) 0.3%
Chemco®	(+) 15.7%	(+) 6.5%
Ultra Tack®	(-) 4.9%	(+) 11.9%
Earth Guard®	(+) 1.3%	(+) 6.4%

(+) indicates an increase in runoff over bare soil conditions

(-) indicates a decrease in runoff over bare soil conditions

Table 5-4
Comparative Soil Loss from Seven Hydraulic Practices
For a Fine-Grained Soil

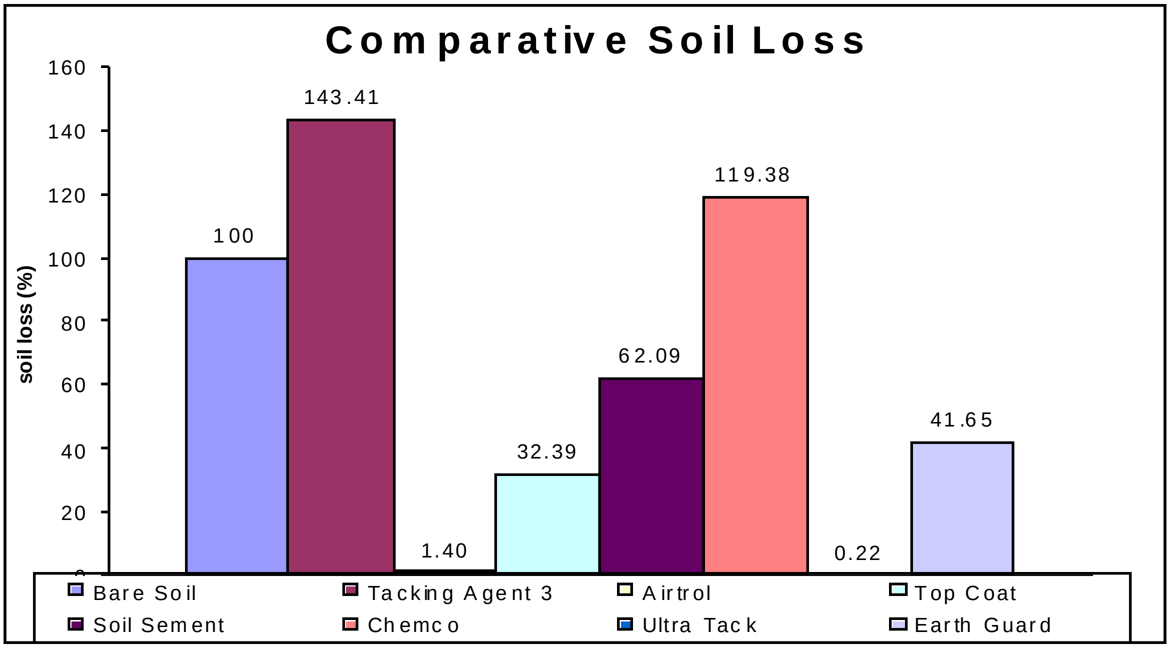

Table 5-5
Comparative Soil Loss from Seven Hydraulic Practices
For a Coarse-Grained Soil

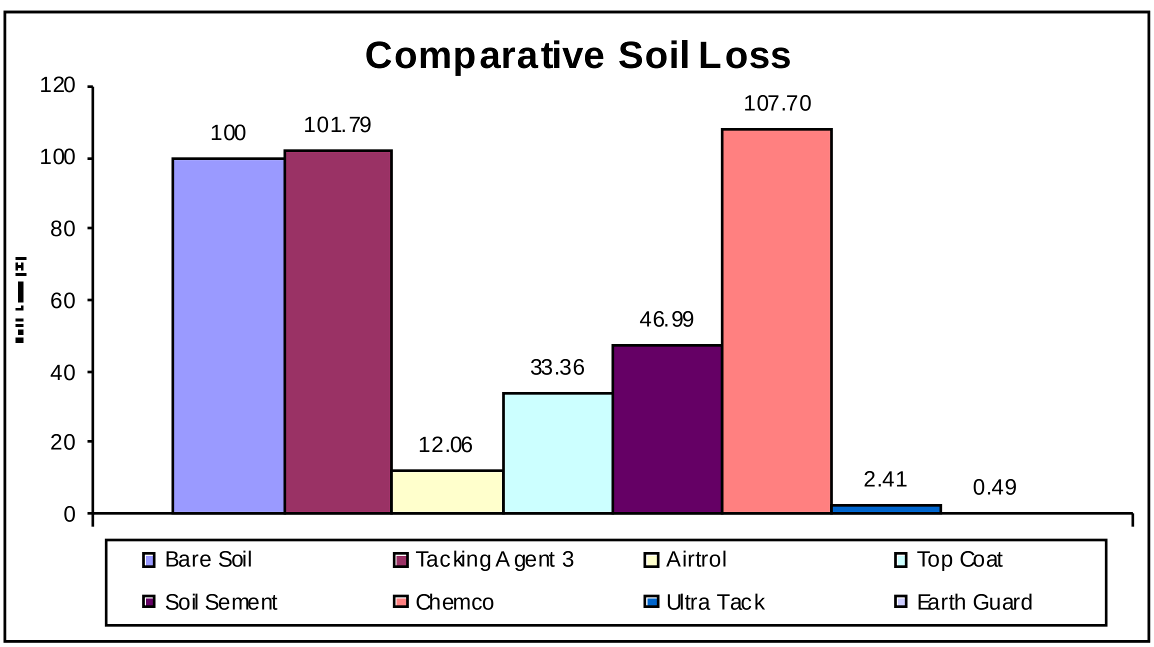

Table 5-6
A Comparison of Soil Loss Values for Seven Hydraulic Practices
For Fine-Grained Versus Coarse-Grained Soils

TREATMENT	FINE-GRAINED	COARSE-GRAINED
Bare soil	100%	100%
Tacking Agent III®	(+) 43.4%	(+) 1.8%
Airtrol®	(-) 98.6%	(-) 87.9%
Top Coat	(-) 67.6%	(-) 66.6%
Soil Sement®	(-) 47.9%	(-) 53.0%
Chemco®	(+) 19.4%	(+) 7.7%
Ultra Tack®	(-) 99.8%	(-) 97.6%
Earth Guard®	(-) 58.3%	(-) 99.5%

(+) indicates an increase in soil loss over bare soil conditions

(-) indicates a decrease in soil loss over bare soil conditions

5.2 OBSERVATIONS

It appears that the various hydraulic applications have little impact on runoff. Runoff volumes for most products do not appear to vary significantly compared to the average runoff values for both the coarse and fine soils. All of the seven hydraulic measures were within 20% of the runoff values for both coarse and fine soils.

A wide range in soil loss was observed, some products erosion control effectiveness varied based on soil texture (e.g., coarse versus fine soil). A few products appeared to perform better when compared to a “coarse” bare soil control, and performed somewhat worse when compared to a “fine” soil control (Tables 5-4, 5-5 and 5-6). Most appeared to function relatively the same regardless of soil texture.

Results from the water quality analysis demonstrate a wide range of variation between products as well as between soil types and constituent concentrations (Table 5-7). Given the limitation of the two-consecutive storm test design, significance of these variations is difficult to ascertain but can point towards future, expanded evaluation of specific products for their water quality impact.

Water Quality Testing Results
Table 5-7

				Fine Graded Soil								Coarse Graded Soil							
			EPA Method	Bare Soil	Earth Guard®	Soil Sement®	Tacking Agent III®	Airtrol®	Ultra Tack®	Chemco®	Top Coat	Bare Soil	Earth Guard®	Soil Sement®	Tacking Agent III®	Airtrol®	Ultra Tack®	Chemco®	Top Coat
pH		pH units	150.1	8.40	8.01	8.055	8.34	7.66	7.3	8.32	7.86	8.95	6.85	8.38	8.68	7.57	7.06	8.67	8.01
TSS	Total Suspended Solids	mg/L	160.2	27690.21	2464	15224.41	31381	2844.70	732.5	36523.58	8493	6253	130	5218	30645	7162	580	29271	9168
BOD	Biological Oxygen Demand	mg/L	405.1	3.33	9.35	19.08	4.01	24.68	32.4	4.3	76	D	286.5	6.5	D	8	36	2.5	93.5
COD	Chemical Oxygen Demand	mg/L		36.08	1251.85	99.51	45.66	101.25	161.9	93.66	89.95	25.5	372	30	18	36.5	140	30.5	64
TOC	Total Organic Carbon	mg/L	415.2	4.12	7.95	23.85	6.105	11.3	38.7	5.55	14.31	4.85	107.2	9.4	7.35	8.9	44.3	4.3	15.9
NO_3	as Nitrogen	mg/L	353.3	0.45	0.71	0.28	0.50	0.38	D	1.03	D	0.37	0.2	0.76	0.89	0.31	0.10	1.03	0.34
TKN	Total Kjedahl Nitrogen	mg/L	351.4	8.57	4.89	2.93	4.015	6.3	9.03	D	5.85	4.51	20.41	7.19	12.8	2.86	8.36	20.05	8.62
P	Phosphorous	mg/L	365.2	0.18	0.06	0.12	0.08	0.06	0.08	0.06	0.06	0.46	0.1	0.23	0.11	0.08	0.05	0.14	0.07
Al	Dissolved Aluminum	ug/L	200.7	D	565	D	D	495.41	585	439.58	585	325	320	335	230	340	385	250	265
As	Dissolved Arsenic	ug/L	206.2	D	D	D	D	D	D	D	D	D	D	D	13.5	D	D	15	10
Ba	Dissolved Barium	ug/L	200.7	23.33	50	50.83	53.33	40.41	85	33.33	45	215	45	42	40	55	45	54.5	60
Ca	Dissolved Calcium	ug/L	200.7	44687.50	84350	89950	81783.33	647125	172650	83641.66	577000	4700	37700	23000	22900	589500	28550	33200	281500
Cd	Dissolved Cadmium	ug/L	200.7	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Cr	Dissolved Chromium	ug/L	200.7	D	D	30	25	D	D	20	D	D	D	D	D	D	D	D	D
Cu	Dissolved Copper	ug/L	200.7	D	D	10	10	D	D	10	D	D	D	D	D	D	D	D	D
Fe	Dissolved Iron	ug/L	200.7	D	375	86.66	85	257	180	75	805	D	D	30	D	D	D	D	D
Hg	Dissolved Mercury	mg/L	245.1	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Li	Dissolved Lithium	ug/L	200.7	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Mg	Dissolved Magnesium	ug/L	200.7	12644.17	40950	16745.83	35426.66	64545.83	42650	33629.16	79650	800	7665	4100	4550	27250	5970	6500	14300
Ni	Dissolved Nickel	ug/L	200.7	D	D	D	D	D	D	D	D	D	70	D	D	D	D	D	D
Pb	Dissolved Lead	ug/L	200.7	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Tl	Dissolved Thallium	ug/L	279.2	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
V	Dissolved Vanadium	ug/L	200.7	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Zn	Dissolved Zinc	ug/L	200.7	D	D	48.33	36.66	119.375	195	28.95	D	115	165	D	D	D	D	D	13030

D= below limit of detection

5.3 STATISTICAL COMPARISON OF SEVEN SLOPE STABILIZERS AND BARE SOIL

The objective of the statistical analysis of data from the Caltrans Hydraulic Application Study (CHAS) was to compare the efficacy of seven hydraulically-applied erosion control products to bare soil, applied to fine and course soil test beds in terms of soil loss, runoff, and 24 water quality measurements.

5.4 BACKGROUND SUMMARY

Seven hydraulic erosion control products were applied to soil plots at the SDSU Soil Erosion Research Laboratory. They were:

1) Earth Guard®
2) Soil Sement®
3) Airtrol®
4) Ultra Tack®
5) Chemco®
6) Tacking Agent III®
7) Topcoat®

Bare soil control plots were also evaluated for a fine and a coarse textured soil.

Plots at the SDSU indoor laboratory were subjected to simulated rainfall from 10-year storms as defined by the District 7 Erosion Control Pilot Study (ECPS) with runoff collected by the SDSU/SERL staff. The following 24 variables were included in the statistical analysis: *pH*, *TSS* (Total Suspended Solids), *TOC* (Total Organic Carbon), NO_3 (nitrogen), *TKN* (Total Kjedahl Nitrogen), *P* (Phosphrous), *dAs* (Dissolved Arsenic), *dCd* (Dissolved Cadmium), *dCr* (Dissolved Chromium), *dCu* (Dissolved Copper), *dFe* (Dissolved Iron), *dHg* (Dissolved Mercury), *dMg* (Dissolved Magnesium), *dNi* (Dissolved Nickel), *dPb* (Dissolved Lead), *dZn* (Dissolved Zinc), *vol* (runoff volume) and *rate* (runoff rate). Some measurements were below the detectable limits of the laboratory, these values were replaced by one-half of the detectable limit.

5.4.1.1 Product

Each product was applied to soil of two types (coarse and fine) and two sequential storms were simulated, for a total of four conditions. The design of this experiment is a randomized block design, with each of 8 treatments randomly applied to 4 different block conditions: (1) coarse soil, first storm, (2) coarse soil, second storm, (3) fine soil, first storm, (4) fine soil, second storm. A randomized block ANOVA is the appropriate statistical method to compare the efficacy of the products across all conditions. Each response variable, soil loss, runoff, and 24 water quality variables were considered separately.

5.4.1.2 Variable

Each variable was investigated to assess the normality and homskedasticity (having equal statistical variances) assumptions of an ANOVA. As these assumptions were not met for any of the variables, and no simple transformation appeared to rectify the situation, a non-parametric randomized block analysis, the Friedman test (see Conover 1999, pp. 369-372) was performed for each variable. Table 5-8 displays these results. A p-value less than .05 suggests that there are differences among the 8 treatments (these are highlighted with a *).

For the eight response variables that displayed significant differences between the products and bare soil, post-hoc multiple comparisons were done to determine the actual differences. Table 5-9 displays these results. Groups with similar means are listed in the same columns; the first column always contains the bare soil treatment. Treatments that have statistically significantly different means are listed in separate columns. The average response for each group is listed at the bottom of each cell.

5.4.1.3 Interpretation

To illustrate how to interpret these results, we discuss two examples: soil loss and BOD. The p-value of <.001 in Table 5-8 indicates that the amount of soil lost was significantly different among the eight treatments. In Table 5-9, we find that Tacking Agent III® and Chemco® were not significantly different from bare soil, and that the average soil lost per storm in this group was 42.2 kg. Soil Sement® lost significantly less soil than the bare soil, 28.9 kg on average per storm. Topcoat® lost significantly less soil than bare ground, and significantly less than Soil Sement®, with 12.1 kg lost per storm on average.

The best three products in terms of soil lost were Airtrol®, Ultra Tack and Earth Guard®, which lost significantly less soil than bare soil. All the other products had an average of 4.1 kg per storm. In the second example, BOD is significantly different among the 8 treatments since the p-value is .012. In Table 5-9, we find that Tacking Agent III® and Soil Sement® were not significantly different than bare soil (this group has an average BOD of 13.2 mg/l); additionally Airtrol® and Earth Guard® were not significantly different than bare soil with an average BOD of 82.1. Only Ultra and Topcoat® were significantly different from bare soil with an average BOD of 59.5 mg/l. These results seem a bit counterintuitive, since Airtrol® and Earth Guard® have a higher mean than Ultra Tack® and Topcoat®; however this average is overinflated by Earth Guard®'s very high values on coarse soil (446 and 127). Airtrol® and Earth Guard® were also not significantly different from Ultra Tack® and Topcoat®.

5.4.2 Conclusions:

Airtrol®, Earth Guard®, and Ultra Tack® had the lowest pH, TSS, P, and lowest amount of soil loss. Soil loss, pH, TSS and P were significantly lower than bare soil and significantly better than the other products for Airtrol®, Earth Guard®, and Ultra Tack®. Chemco® and Topcoat® also had low phosphorous. However, TOC, Mg, Ca were significantly higher for Airtrol®, Earth Guard®, and Ultra Tack® than for bare soil. Additionally, BOD for Ultra Tack® was significantly higher than for bare soil.

Results:

TABLE 5-8: ANOVA RESULTS		
Measurements	Test Statistic	p-value
Soil Loss	**32.74**	**<.001 ***
Runoff	**2.19**	**.078**
pH	**24.27**	**<.001 ***
TSS	**11.20**	**<.001 ***
BOD	**3.52**	**0.012 ***
COD	**2.395**	**0.057**
TOC	**3.896**	**0.007 ***
NO_3	**2.214**	**0.075**
TKN	**0.35**	**0.921**
P	5.21	**0.0015 ***
Al	1.037	**0.436**
As	1.846	**0.131**
Ba	0.602	**0.75**
Ca	10.81	**<.001 ***
Cd	1.00	**0.459**
Cr	1.719	**0.159**
Cu	1.00	**0.459**
Fe	0.891	**0.531**
Hg	1.00	**0.459**
Li	1.00	**0.459**
Mg	7.29	**<.001 ***
Ni	1.333	**0.384**
Pb	1.00	**0.459**
Tl	0.0	**1.0**
V	0.818	**0.583**
Zn	0.926	**0.507**

TABLE 5-9: MULTIPLE COMPARISONS

Measurements	Bare Soil Group	Group 2	Group 3	Group 4
Soil Loss	Tacking Agent III® Chemco® 42.2 kg	Soil Sement® 28.9 kg	Topcoat® 12.1 kg	Airtrol® Earth Guard® Ultra Tack® 4.1 kg
pH	8.68	Tacking Agent III® Chemco® 8.51	Topcoat® Soil Sement® 8.08	Airtrol® Earth Guard® Ultra Tack® 7.41
TSS	Tacking Agent III® Chemco® Topcoat® Soil Sement® 19,986	Airtrol® Earth Guard® Ultra Tack® 2309		
BOD	Tacking Agent III® Chemco® Soil Sement® 13.2	Topcoat® Ultra Tack® 59.5		
	Airtrol® Earth Guard® 82.1			
TOC	Tacking Agent III® Chemco® 5.38	Airtrol® Earth Guard® Soil Sement® Topcoat® Ultra Tack® 28.2		
P	Tacking Agent III® Soil Sement® 0.20	Airtrol® Earth Guard® Chemco® Topcoat® Ultra Tack® 0.08		
Ca	24,694	Tacking Agent III® Soil Sement® Earth Guard® Chemco® Ultra Tack® 65,772	Airtrol® Topcoat® 523,781	
Mg	Soil Sement® 8,572	Tacking Agent III® Chemco® Ultra Tack® 21,454	Airtrol® Topcoat® 46,436	
		Earth Guard 24,307		

6.1 SUMMARY AND CONCLUSIONS

The primary objective of the Caltrans Hydraulic Application Study (CHAS) was to assess the performance of seven hydraulically-applied erosion control products applied to soil plots at the San Diego State University Soil Erosion Research Laboratory (SDSU/SERL). A secondary project goal was to use the erosion control performance and water quality data generated by the study to make statewide recommendations on specification and use of the hydraulic practices tested.

CHAS examined the erosion potential of two (2) distinctly different, custom-blended soils characteristic of two soils typically found on fill slopes with District 7 (Los Angeles). Seven (7) erosion control products were hydraulically applied to the two different soil types. The erosion control products tested included Earth Guard®, Soil Sement®, Airtrol®, Ultra Tack®, Chemco®, Tacking Agent III®, Topcoat®.

Each hydraulic application was subjected to two (2) sequential simulated storm events, each representing a 10-year storm as predicted for the Los Angeles Basin. The hydraulic soil stabilizers were compared using a variety of criteria, including soil loss, runoff, and 24 water quality measurements: pH, TSS, BOD, COD, TOC, NO_3, TKN, P, dissolved Al, As, Ba, Ca, Cd, Cr, Cu, Fe, Hg, Li, Mg, Ni, Pb, TI, V, Zn.

This experiment had a randomized block design, with eight soil treatments (seven products and a bare soil) applied to each of four soil conditions (fine and coarse soils, storms 1 and 2). Each response variable, e.g., soil loss, runoff, and 24 water quality variables was considered separately. A non-parametric randomized block analysis, the Friedman test was performed for each variable.

Post-hoc multiple comparisons done to determine what the actual differences between products for eight response variables displayed significant differences between the products and bare soil. Airtrol®, Earth Guard®, and Ultra Tack® had the lowest pH, TSS, and P and the lowest amount of soil loss. Soil loss, pH, TSS and P were significantly lower than bare soil for and significantly better than the other products for Airtrol®, Earth Guard®, and Ultra Tack®. Chemco® and Topcoat® also had low phosphorous. However, TOC, Mg, Ca were significantly higher for Airtrol®, Earth Guard®, and Ultra Tack® than for bare soil. Additionally, BOD for Ultra Tack® appears to be significantly higher than for bare soil.

It appears that the various hydraulic applications have little impact on runoff. Runoff volumes for most products do not appear to vary significantly around the average runoff values for both the coarse and fine soils. All of the seven hydraulic measures were within

20% of the runoff values for both coarse and fine soils. This is an important observation from a field application standpoint in that none of the applications appear to accelerate runoff volumes or velocities beyond baseline conditions nor do they appear to increase infiltration or water holding capacity of the soil, which might affect slope stability.

A wide range of soil loss was observed, with some hydraulic applications' erosion control effectiveness varying based on soil texture (e.g., coarse versus fine soil). An example of soil-specific performance can be seen in the Earth Guard® application, where the application reduced erosion by 99.5% on a coarse-grained soil, but only by 58% on a fine-grained soil. This may be the result of a difference in recommended application rate (6-7 gallons per acre for the fine-grained soil versus 10 gallons per acre for the coarse-grained soil) and/or the recommended use of mulch in one application (coarse-grained soil) and not in the other (fine-grained soil). In contrast, Topcoat® reduced erosion by approximately 67% on both a coarse-grained and a fine-grained soil.

A few of the products appeared to perform better when compared to a "coarse" bare soil control, and performed somewhat worse when compared to a "fine" soil control. Most of the hydraulic products appeared to function relatively the same regardless of soil texture. It is important to note that these results represent the average soil losses from two consecutive storms; additional storm applications would be necessary to establish the statistical significance of this phenomenon.

The data generated from the water quality analysis of the runoff for some products were significantly different when compared to the bare soil controls. For example, average COD values were significantly higher for Earth Guard®, and Ultra Tack® on both the coarse and fine soils than for the control plots. Additionally, when the data from the first consecutive storm is compared against the second consecutive storm, it is apparent that the larger COD values are obtained for the first consecutive storm. For example, Earth Guard®, tested on a fine soil, yielded values of 2,500 mg/l COD in the first consecutive storm and values of 3.70 mg/l in the second consecutive storm. While the average of these values (1,251.85 mg/l) is significantly above the bare soil control (36.08 mg/l), it also appears that much of the hydraulic product is removed from the soil during the first rainfall flush.

Earth Guard® was not the only product to exhibit "first flush" loss of material. Close examination of data from other product tests demonstrates elevated constituent concentrations in the first consecutive storm when compared to the second consecutive storm. This phenomenon is generally true for those products that performed well (e.g., reduced soil loss when compared to a bare soil control), and also for those products that performed poorly (e.g., soil losses higher than bare soil controls). The significance of this phenomenon is related to actual field applications, where loss of hydraulically-applied materials during rain events might reduce erosion control effectiveness as well as have off-site impacts to water bodies.

Results from the water quality analysis demonstrate a wide variation in performance between hydraulic applications as well as between soil types and constituent concentrations in runoff water. Given the limitation of the two-consecutive storm test design, significance of these variations is difficult to ascertain but points towards future expanded evaluation of specific products for their water quality impact.

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Thomson, N.R., E. McBean, I. Mostrenko, and W. Snodgrass. 1994. “Characterization of Stormwater Runoff from Highways” in *Current Practices in Modeling the Management of Stormwater Impacts*, W. James, ed.

The primary objective of the Laboratory Correlation Study (LCS) was to assess the consistency of soil erosion and water-quality measurements taken in the field through the Temporary/Permanent Soil Stabilization Evaluation Study (TPSSES) and at the SDSU Soil Erosion Research Laboratory (SDSU/SERL) when seven hydraulically-applied erosion control products were applied to “fine” and “course” soil plots. A secondary project goal – if a correlation between field and laboratory studies was established - was to use erosion control performance and water quality data to make statewide recommendations on specification and use of the hydraulic practices that were tested.

Differences in study design between the TPSSES and the normal SDSU/SERL procedures appear to have had an adverse effect on establishing a relationship between field and laboratory results. In addition, gaps in the field data collection occurred due to failure of the sequential samplers during storm events and the fact that all hydraulic materials were not applied at the same time.

Differences between the field and laboratory plot sizes, rainfall amounts and storm duration appear to have influenced the differential performance of the various products tested. However, there was not sufficient data to determine the effects of these variables on water quality and the design of the two experiments did not allow these effects to be estimated. It appears that in particular, rainfall amounts of the two experiments were so different that water quality measurements may be due to differences in the rainfall amounts of the experiments.

The correlation between the SDSU/SERL and the TPSSES values were calculated for each water quality measurement separately. As a result:

1) Only total suspended solids (TSS) and total organic carbon (TOC) show reasonable correlation of lab and field data with R-squared values of 52.7% and 36.5%
2) Although the R-squared values for *dFe* and *dMg* are moderately large, these values are artificially inflated by the small number of data points available for analysis
3) Logarithmic transformations of the data were explored but did not increase the correlation of the measurements: all R-squared values remained below 25%.
4) Total Suspended Solids exhibited a significant and moderately good correlation between the field and lab measurements when the data was logarithmically transformed. Although there is not perfect agreement of the field and lab values, there is a strong linear correlation in these values (e.g., when the lab values were high, so were the field values; when the lab values were low, so were the field values).
5) All other water-quality measurements show poor correlation of field and lab data.

A direct correlation between indoor laboratory performance and field performance – a relationship that some specifiers or designers might require to approve material usage - was not established as a result of this study. The SDSU study team considers the differences in study design and data collection procedures to account for the apparent lack of correlation.

COMPACTION PROCEDURES

The placement and preparation of soil in the test bed can be divided into two distinct activities: 1) the initial "filling" of the test bed with a base layer of compacted soil 30-40 centimeters (12 to 16 inches) deep, and 2) the creation of a second 10-centimeter (4-inch) "testing" layer of soil on top of the fill layer.

1. The "fill layer" of soil is placed in the bed in 10-centimeter (4-inch) lifts. Each lift is moistened to optimum moisture content as determined by an initial series of Modified Proctor tests (ASTM D1557) for the soil being evaluated. A mechanical whacker is used to compact each lift. Following compaction, eight randomly positioned sand cone tests are performed (ASTM D1556) to verify 95 percent relative compaction of the fill layer.
2. After placement of the fill layer and compaction as described, the top 10 centimeters (4 inches) of compacted soil are loosened using a rotor-tiller. After tilling, the soil is then recompacted by hand using an 20-centimeter by 20–centimeter (8-inch by 8-inch) hand tamp weighing 5 kilograms (11 pounds). Following hand-tamping, the soil is lightly raked perpendicular to the length of the test plot and is considered ready for testing.

Following each rainfall simulation test, the eroded soil is removed to a depth of 5 to 10 centimeters (2 to 4 inches), depending on saturation, and replaced with new, untested soil from storage bins located inside the laboratory. The rotor-tilling and hand compaction steps are then repeated in preparation for the next test.

SAND CONE TESTING PROCEDURE (ASTM D1556)

1. Prepare a level surface in the fill and dig a cylindrical hole about 5 inches (125 millimeters) in diameter and about 5 inches (125 millimeters) deep. Save all of the soil that comes out of the hole and determine its weight.
2. Fill the sand cone apparatus with a special free-flowing SP sand, of a known density, similar to that found in an hourglass. Then determine the weight of the cone and the sand.
3. Place the sand cone over the hole. Then open the valve and allow the sand to fill the hole and the cone.
4. Close the valve, remove the sand cone from the hole, and determine its new weight.
5. Through comparing the weight of the sand used in the test with the weight of the soil removed from the hole the density of the soil can be determined.

Nuclear Density Testing is performed in accordance with ASTM D2922.

COMPACTION TEST REPORT

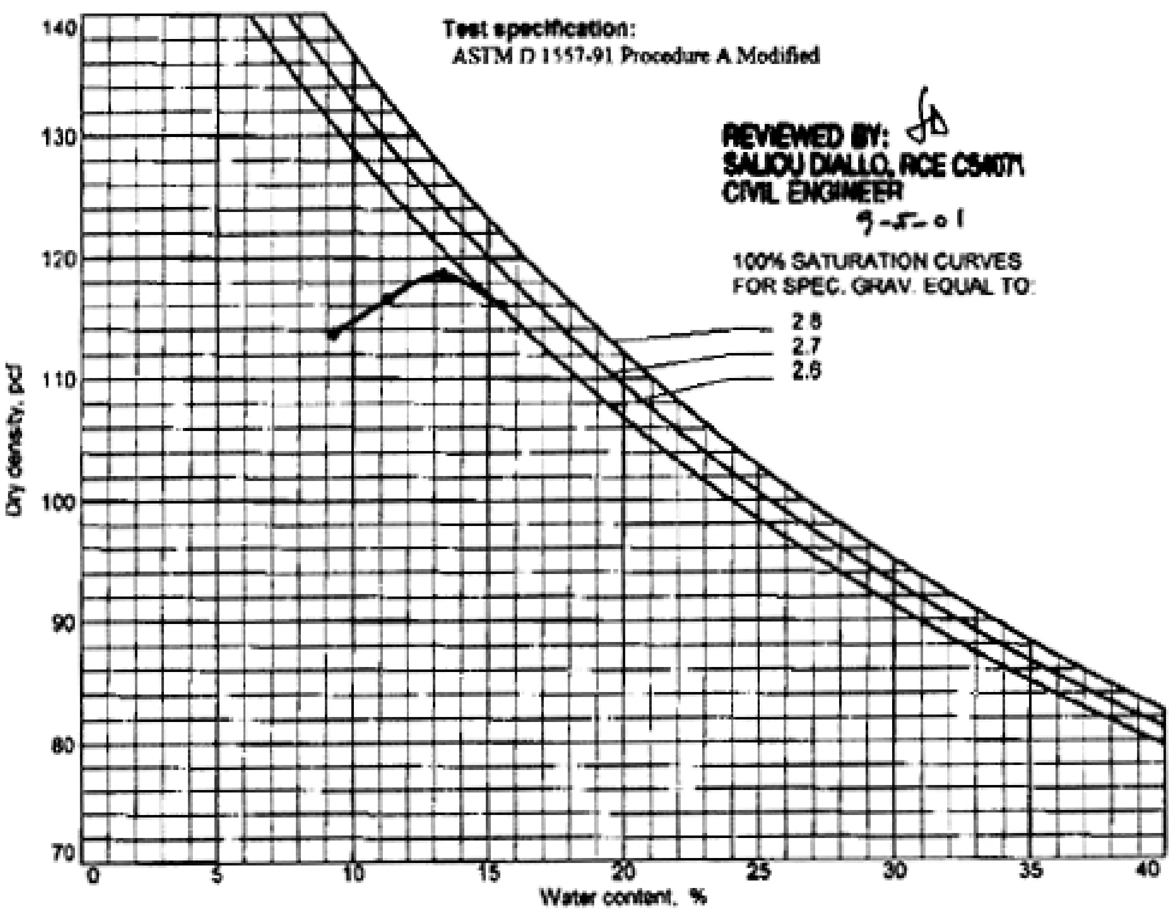
Project No.: 99-711 **Date:** 8/29/01
Project: SOIL TESTING
CALTRANS DISTRICT 7 EROSION CONTROL PILOT STUDY
Location: Not submitted
Elev./Depth:
Remarks: TESD NO. 2157

MATERIAL DESCRIPTION

Description: BROWN CLAYEY SAND (SC)

Classifications - **USCS:** **AASHTO:**
Nat. Moist. = **Sp.G. =**
Liquid Limit = **Plasticity Index =**
% > No.4 = % **% < No.200 =**

TEST RESULTS
Maximum dry density = 118.5 pcf
Optimum moisture = 13 %



Plate

Project No.: 99-711 **Date:** 7/11/01

Project: SOIL TESTING
CALTRANS DISTRICT 7 EROSION CONTROL PILOT STUDY

Location: UNKNOWN

Elev./Depth:

Remarks: TESD NO. 1715

MATERIAL DESCRIPTION

Description: GRAY-BROWN SILTY SAND (SM)

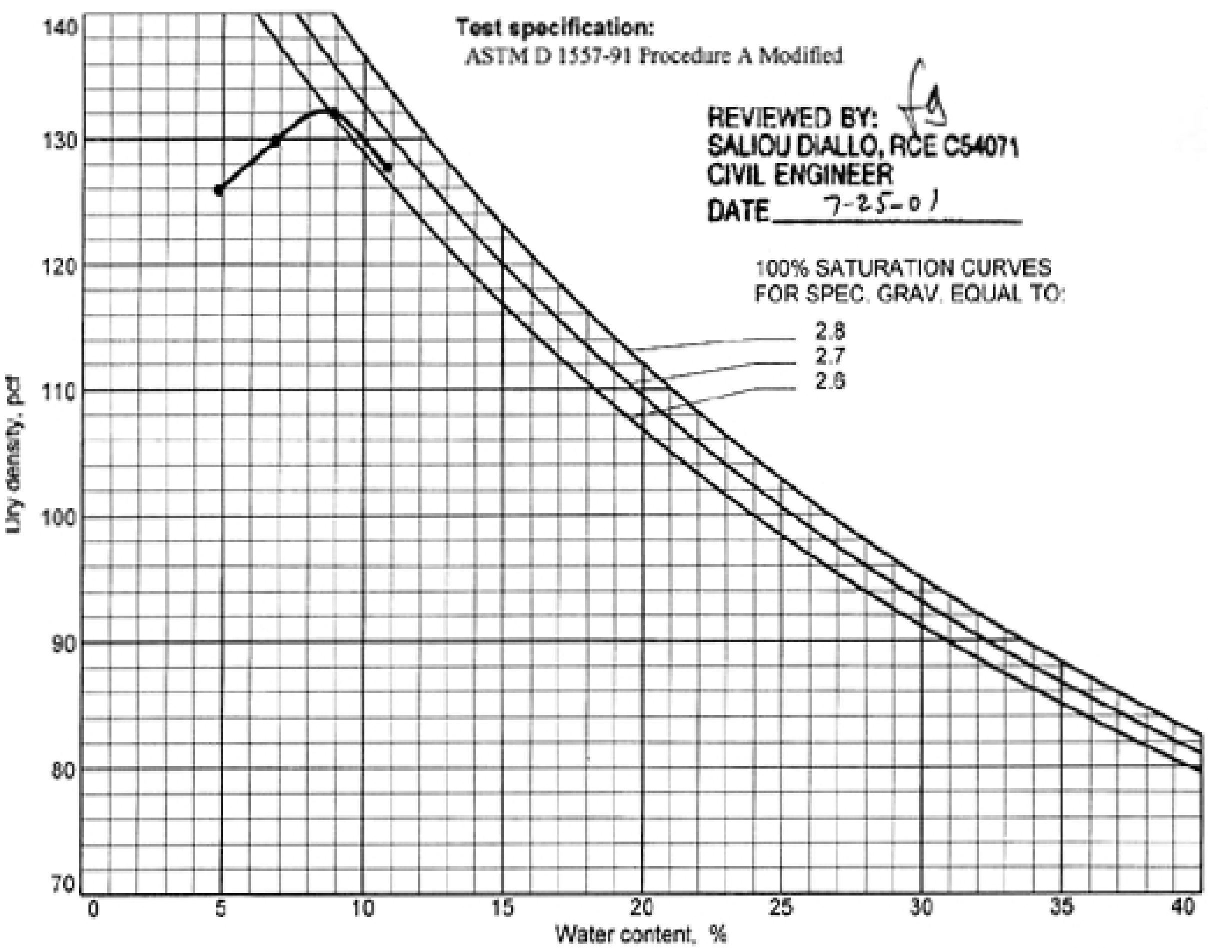
Classifications - **USCS:** **AASHTO:**

Nat. Moist. = **Sp.G. =**

Liquid Limit = **Plasticity Index =**

% > No.4 = % **% < No.200 =**

TEST RESULTS
Maximum dry density = 132 pcf
Optimum moisture = 8.5 %



Plate

TEST DATE: 7/11/01 | TREATMENT: Bare Soil | SOIL TYPE: fine graded | SLOPE: 2:1

TEST TIME: 1:00 p | REPLICATE NUMBER: 1 | STORM TYPE: 10yr-2 | TEST CREW: chris, sung

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	0	gallons	7.13	kg	6	11.2	43.9	11.7	6440.00	0.06	4.09	4.09
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg								
PERIOD 2	1	5 gal / 32 gal	500	15	gallons	18.28	kg	58	12.2	92.4	72.4	33.22	10.98	3.82	60.59
	2	5 gal / 32 gal			gallons	11.92	kg	15	10.9	48.3	20.7	281.63	2.86	8.06	8.06
	3	5 gal / 32 gal	500	20	gallons	13.85	kg	31	11.3	76.3	58.7	37.13	7.43	2.94	78.64
	4	5 gal / 32 gal			gallons	10.16	kg	19	10	42.7	19.4	247.87	2.63	6.53	6.53
	5	5 gal / 32 gal	500	20	gallons	13.27	kg	84	8.8	75.5	58.8	33.40	7.21	2.58	78.28
	6	5 gal / 32 gal			gallons	9.88	kg	67	8.9	41.8	17	306.17	2.19	6.69	6.69
	7	5 gal / 32 gal	500	20	gallons	13.74	kg	44	11	85.3	68	30.35	7.75	2.51	78.21
	8	5 gal / 32 gal			gallons	10.46	kg	104	10.7	43.5	17.6	375.36	1.99	7.47	7.47
													43.05		324.46
PERIOD 3	1	5 gal / 32 gal	500	20	gallons	11.61	kg	5	11.1	57.7	29	160.34	2.81	5.32	81.02
	2	5 gal / 32 gal			gallons		kg						2.81		62.09
	3	5 gal / 32 gal			gallons		kg								

TEST DATE: 7/12/01 TREATMENT: Bare Soil SOIL TYPE: fine graded SLOPE: 2:1

TEST TIME: 1:00 p REPLICATE NUMBER: 2 STORM TYPE: 10yr-2 TEST CREW: chris, sung

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	13	gallons	12.46	kg	10	11.1	53.7	28.5	144.83	3.87	5.61	54.81
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg								
PERIOD 2	1	5 gal / 32 gal	500	20	gallons	15.91	kg	63	9	85	68.9	26.88	9.69	2.74	78.44
	2	5 gal / 32 gal			gallons	10.99	kg	52	12	37.6	16.3	495.35	1.68	8.31	8.31
	3	5 gal / 32 gal	500	20	gallons	13.79	kg	66	8.9	77	61.2	30.21	7.80	2.51	78.21
	4	5 gal / 32 gal			gallons	11.89	kg	74	8.9	40.5	20.5	172.41	4.00	6.89	6.89
	5	5 gal / 32 gal	500	20	gallons	13.42	kg	51	12	76.8	61	32.24	7.39	2.55	78.25
	6	5 gal / 32 gal			gallons	13.4	kg	16	11.3	46.8	17.5	472.58	2.17	10.23	10.23
	7	5 gal / 32 gal	500	18.5	gallons	14.67	kg	69	8.9	66.7	50	40.63	7.81	3.38	73.40
	8	5 gal / 32 gal			gallons	16.13	kg	54	12.1	41.6	15.3	821.88	1.64	13.49	13.49
													42.18		347.22
PERIOD 3	1	5 gal / 32 gal	500	20	gallons	5.6	kg	79	8.9	55.1	39.6	50.49	1.24	0.88	76.58
	2	5 gal / 32 gal			gallons	12.03	kg	72	8.9	38.3	11.3	1125.00	0.90	10.13	10.13
	3	5 gal / 32 gal			gallons		kg						2.14		67.78

TEST DATE: 8/7/01 | TREATMENT: Earthguard | SOIL TYPE: fine graded | SLOPE: 2:1

TEST TIME: 1:00 p | REPLICATE NUMBER: 1 | STORM TYPE: 10yr-2 | TEST CREW: chris, sung

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	7.6	gallons	0	kg								28.77
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg								
PERIOD 2	1	5 gal / 32 gal	500	17	gallons	7.97	kg	16	11.4	48.8	18.6	419.44	0.46	4.03	68.37
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal	500	20	gallons	10.16	kg	65	8.9	51.7	27.3	132.61	2.59	4.09	79.79
	4	5 gal / 32 gal			gallons		kg								
	5	5 gal / 32 gal	500	21.25	gallons	11.78	kg	31	11.2	61	25.9	238.78	2.10	6.20	86.63
	6	5 gal / 32 gal			gallons		kg								
	7	5 gal / 32 gal	500	21	gallons	14.67	kg	80	8.9	53.2	25.1	173.46	3.77	7.42	86.90
	8	5 gal / 32 gal			gallons		kg								
													8.92		321.70
PERIOD 3	1	5 gal / 32 gal	500	21.5	gallons	11.6	kg	19	10.1	41.2	14.5	606.82	0.72	7.40	88.78
	2	5 gal / 32 gal			gallons		kg						0.72		69.85
	3	5 gal / 32 gal			gallons		kg								

TEST DATE: 8/8/01 **TREATMENT: Earthguard** **SOIL TYPE: fine graded** **SLOPE: 2:1**

TEST TIME: 1:00 p **REPLICATE NUMBER: 2** **STORM TYPE: 10yr-2** **TEST CREW: billy, sung**

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	10	gallons	8.44	kg	54	12.1	43.4	13.8	1741.18	0.30	5.16	43.01
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg								
PERIOD 2	1	5 gal / 32 gal	500	20	gallons	16.61	kg	83	8.9	63.8	39.2	81.19	7.02	6.11	81.81
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal	500	20.5	gallons	16.49	kg	50	12	63.9	29.2	201.74	3.98	9.03	86.63
	4	5 gal / 32 gal			gallons		kg								
	5	5 gal / 32 gal	500	20.25	gallons	19.19	kg	53	12	60.9	45.1	47.73	10.47	5.24	81.88
	6	5 gal / 32 gal			gallons		kg								
	7	5 gal / 32 gal	500	20	gallons	20.27	kg	61	11.9	67.4	33.2	160.56	6.14	10.65	86.35
	8	5 gal / 32 gal			gallons		kg								
													27.61		336.67
PERIOD 3	1	5 gal / 32 gal	500	22.5	gallons	10.72	kg	52	12	51.2	23.5	240.87	1.77	5.47	90.63
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg						1.77		71.71

TEST DATE: 7/14/01 **TREATMENT: Soil Sement** **SOIL TYPE:** **SLOPE: 2:1**

TEST TIME: 1:00 pm **REPLICATE NUMBER: 1** **STORM TYPE: 10yr-2** **TEST CREW: Chris, Sung**

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	12	gallons	0	kg								45.42
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg								
PERIOD 2	1	5 gal / 32 gal	500	18.5	gallons	16	kg	101	11.4	46.3	18.1	420.90	2.00	10.52	80.54
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal	500	23.25	gallons	16.7	kg	64	9.1	60.8	40.1	66.77	7.73	5.49	93.49
	4	5 gal / 32 gal			gallons		kg								
	5	5 gal / 32 gal	500	22.5	gallons	18.27	kg	9	10.8	37.5	22.5	128.21	6.20	8.59	93.75
	6	5 gal / 32 gal			gallons		kg								
	7	5 gal / 32 gal	500	23	gallons	20.77	kg	131	10.9	49.1	26.4	146.45	6.72	10.57	97.63
	8	5 gal / 32 gal			gallons		kg								
													22.64		365.42
PERIOD 3	1	5 gal / 32 gal	500	23	gallons	10.13	kg	65	8.9	50.3	23.3	187.50	1.99	4.66	91.72
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg						1.99		72.79

TEST DATE: 7/15/01 **TREATMENT: Soil Sement** **SOIL TYPE:** **SLOPE: 2:1**

TEST TIME: 1:00 pm **REPLICATE NUMBER: 2** **STORM TYPE: 10yr-2** **TEST CREW: Chris, Sung**

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	11	gallons	11.79	kg	81	8.9	37.1	13.3	540.91	1.37	7.44	49.07
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg								
PERIOD 2	1	5 gal / 32 gal	500	19	gallons	13.69	kg	83	8.9	76.3	57.5	38.68	7.22	2.99	74.90
	2	5 gal / 32 gal			gallons	8.75	kg	50	12	37.6	17.1	401.96	1.54	6.21	6.21
	3	5 gal / 32 gal	500	20.75	gallons	11.77	kg	35	11.1	62.2	46.6	43.94	5.61	2.68	81.22
	4	5 gal / 32 gal			gallons	9.57	kg	53	12	36.8	16.3	476.74	1.49	7.08	7.08
	5	5 gal / 32 gal	500	21.5	gallons	11.78	kg	56	12.2	66.8	50.9	41.09	5.74	2.56	83.94
	6	5 gal / 32 gal			gallons	8.1	kg	59	12	39.3	18.1	347.54	1.59	5.51	5.51
	7	5 gal / 32 gal	500	21.75	gallons	11.96	kg	80	8.9	66.1	50.9	36.19	6.09	2.39	84.71
	8	5 gal / 32 gal			gallons	10.25	kg	61	12	42.4	17.5	452.73	1.67	7.58	7.58
													30.95		351.15
PERIOD 3	1	5 gal / 32 gal	500	22.5	gallons	12.09	kg	14	11.3	57.6	30.2	144.97	3.22	5.39	90.55
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg						3.22		71.63

TEST DATE: 7/24/01 **TREATMENT: Airtrol** **SOIL TYPE: Fine Graded** **SLOPE: 2:1**

TEST TIME: 10:00 am **REPLICATE NUMBER: 1** **STORM TYPE: 10yr-2** **TEST CREW: Chris, Sung**

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	0.4	liters / **gal**	0	g / **kg**								1.51
	2	5 gal / 32 gal			liters / gal		g / kg								
	3	5 gal / 32 gal			liters / gal		g / kg								
PERIOD 2	1	5 gal / 32 gal	500	12.25	liters / **gal**	5.76	g / **kg**	74	8.9	36.8	13.5	506.52	0.02	2.26	48.63
	2	5 gal / 32 gal			liters / gal		g / **kg**								
	3	5 gal / 32 gal	500	20.75	liters / **gal**	6.72	g / **kg**	31	11.2	41.1	16.3	486.27	0.14	3.10	81.64
	4	5 gal / 32 gal			liters / gal		g / **kg**								
	5	5 gal / 32 gal	500	22	liters / **gal**	5.94	g / **kg**	64	9	39.7	15	411.67	0.08	2.38	85.65
	6	5 gal / 32 gal			liters / gal		g / **kg**								
	7	5 gal / 32 gal	500	22	liters / **gal**	7.61	g / **kg**	35	11.2	44.8	17.8	409.09	0.41	3.72	86.99
	8	5 gal / 32 gal			liters / gal		g / **kg**								
													0.65		302.91
PERIOD 3	1	5 gal / 32 gal	500	25	liters / **gal**	5.47	g / **kg**	72	8.9	39.3	11.7	985.71	0.02	1.97	96.60
	2	5 gal / 32 gal			liters / gal		g / **kg**								
	3	5 gal / 32 gal			liters / gal		g / kg						0.02		77.67

TEST DATE: 7/25/01 | TREATMENT: Airtrol | SOIL TYPE: Fine Graded | SLOPE: 2:1

TEST TIME: 10:00 am | REPLICATE NUMBER: 2 | STORM TYPE: 10yr-2 | TEST CREW: Chris, Sung

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	6.75	liters / **gal**	4.84	g / **kg**	31	11.3	42.5	12	4357.14	0.04	1.32	26.87
	2	5 gal / 32 gal			liters / gal		g / kg								
	3	5 gal / 32 gal			liters / gal		g / kg								
PERIOD 2	1	5 gal / 32 gal	500	20	liters / **gal**	7.25	g / **kg**	6	11.2	45.4	14.2	1040.00	0.02	3.75	79.45
	2	5 gal / 32 gal			liters / gal		g / **kg**								
	3	5 gal / 32 gal	500	23.5	liters / **gal**	7.88	g / **kg**	10	11.1	45.8	14.2	1019.35	0.03	4.37	93.32
	4	5 gal / 32 gal			liters / gal		g / **kg**								
	5	5 gal / 32 gal	500	22	liters / **gal**	9.4	g / **kg**	66	8.9	44.2	11.3	1370.83	0.10	5.82	89.09
	6	5 gal / 32 gal			liters / gal		g / **kg**								
	7	5 gal / 32 gal	500	22	liters / **gal**	9.16	g / **kg**	54	12.1	47.4	14.8	1207.41	0.32	5.36	88.63
	8	5 gal / 32 gal			liters / gal		g / **kg**								
													0.47		350.49
PERIOD 3	1	5 gal / 32 gal	500	24.5	liters / **gal**	9.08	g / **kg**	69	8.9	46.3	10.1	3016.67	0.15	5.45	98.18
	2	5 gal / 32 gal			liters / gal		g / **kg**								
	3	5 gal / 32 gal			liters / gal		g / kg						0.15		79.26

TEST DATE: 8/3/01 **TREATMENT: Ultra Tack** **SOIL TYPE: fine graded** **SLOPE: 2:1**

TEST TIME: 1:00 p **REPLICATE NUMBER: 1** **STORM TYPE: 10yr-2** **TEST CREW: chris, sung**

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	1.3	gallons	0	kg								4.92
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg								
PERIOD 2	1	5 gal / 32 gal	500	10	gallons	5.72	kg	51	12	46.3	17.9	481.36	0.02	2.22	40.07
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal	500	22.5	gallons	5.71	kg	64	9	40.2	15.3	395.24	0.05	2.18	87.34
	4	5 gal / 32 gal			gallons		kg								
	5	5 gal / 32 gal	500	21.5	gallons	6.21	kg	44	11	46.3	15	782.50	0.02	2.71	84.09
	6	5 gal / 32 gal			gallons		kg								
	7	5 gal / 32 gal	500	23	gallons	5.13	kg	54	12.1	48.4	13.4	2692.31	0.02	1.63	88.69
	8	5 gal / 32 gal			gallons		kg								
													0.11		300.18
PERIOD 3	1	5 gal / 32 gal	500	27.5	gallons	6.08	kg	16	11.4	50.1	13.4	1835.00	0.02	2.58	106.67
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg						0.02		87.74

TEST DATE: 8/4/01 **TREATMENT: Ultra Tack** **SOIL TYPE: fine graded** **SLOPE: 2:1**

TEST TIME: 1:00 p **REPLICATE NUMBER: 2** **STORM TYPE: 10yr-2** **TEST CREW: chris, sung**

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	3.9	gallons		kg								14.76
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg								
PERIOD 2	1	5 gal / 32 gal	500	16.6	gallons	6.75	kg	84	8.8	42.8	15.6	400.00	0.25	3.02	65.85
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal	500	21.5	gallons	6.98	kg	10	11.1	48.2	13.2	1666.67	0.02	3.48	84.86
	4	5 gal / 32 gal			gallons		kg								
	5	5 gal / 32 gal	500	22.5	gallons	6.73	kg	101	11.5	50.5	13.3	2066.67	0.02	3.23	88.39
	6	5 gal / 32 gal			gallons		kg								
	7	5 gal / 32 gal	500	22.75	gallons	6.72	kg	52	12	45.3	14.3	1347.83	0.02	3.22	89.33
	8	5 gal / 32 gal			gallons		kg								
													0.31		328.43
PERIOD 3	1	5 gal / 32 gal	500	26.2	gallons	5.09	kg	19	10	39.4	14.1	617.07	0.02	1.59	100.76
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg						0.02		81.83

TEST DATE: 7/20/01 **TREATMENT: PAM** **SOIL TYPE: fine graded** **SLOPE: 2:1**

TEST TIME: 10:00 am **REPLICATE NUMBER: 1** **STORM TYPE: 10yr-2** **TEST CREW: chris, sung**

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	5	gallons	23	kg	35	11.1	38.5	14.3	756.25	2.34	17.68	36.61
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg								
PERIOD 2	1	5 gal / 32 gal	500	18.75	gallons	25.89	kg	59	12	84.2	66.3	32.97	16.73	5.68	76.65
	2	5 gal / 32 gal			gallons	18.1	kg	16	11.4	50.9	19	419.74	3.29	13.81	13.81
	3	5 gal / 32 gal	500	21.25	gallons	21.2	kg	101	11.4	96.4	73.2	37.54	12.75	4.97	85.40
	4	5 gal / 32 gal			gallons	12.24	kg	131	11	36.2	16.5	358.18	2.45	8.79	8.79
	5	5 gal / 32 gal	500	21.5	gallons	20.98	kg	56	12.2	66.3	52.5	34.24	12.91	4.59	85.97
	6	5 gal / 32 gal			gallons	9.97	kg	9	10.8	42.7	17.2	398.44	1.80	7.17	7.17
	7	5 gal / 32 gal	500	23	gallons	17.56	kg	65	8.9	69.9	54.9	32.61	10.49	3.59	90.64
	8	5 gal / 32 gal			gallons	12.11	kg	64	9	41.2	15.4	403.13	2.21	8.90	8.90
													62.63		377.33
PERIOD 3	1	5 gal / 32 gal	500	19.75	gallons	16.63	kg	81	8.9	44.3	15.9	405.71	2.20	10.95	85.70
	2	5 gal / 32 gal			gallons		kg						2.20		66.78
	3	5 gal / 32 gal			gallons		kg								

TEST DATE: 7/21/01 **TREATMENT: PAM** **SOIL TYPE: fine graded** **SLOPE: 2:1**

TEST TIME: 10:30 am **REPLICATE NUMBER: 2** **STORM TYPE: 10yr-2** **TEST CREW: chris, sung**

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	13	gallons	14.63	kg	50	12	47.3	18.2	469.35	2.05	9.60	58.81
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg								
PERIOD 2	1	5 gal / 32 gal	500	22	gallons	12.8	kg	83	8.9	74.8	58.1	33.94	6.83	2.49	85.76
	2	5 gal / 32 gal			gallons	15.05	kg	61	11.9	51.7	28.8	135.50	5.97	8.08	8.08
	3	5 gal / 32 gal	500	23	gallons	14.09	kg	80	8.9	67.8	53.5	32.06	7.91	2.70	89.75
	4	5 gal / 32 gal			gallons	11.49	kg	53	12	49	20.4	340.48	2.38	8.11	8.11
	5	5 gal / 32 gal	500	23	gallons	13.98	kg	52	12	85.1	68.3	29.84	7.97	2.53	89.58
	6	5 gal / 32 gal			gallons	9.84	kg	14	11.3	44.6	18.9	338.16	2.02	6.82	6.82
	7	5 gal / 32 gal	500	22	gallons	14.57	kg	63	8.9	64.4	49.8	35.70	8.04	3.05	86.32
	8	5 gal / 32 gal			gallons	9.38	kg	44	11	42.9	16.7	459.65	1.50	6.88	6.88
													42.62		381.31
PERIOD 3	1	5 gal / 32 gal	500	23	gallons	11.05	kg	72	8.9	40.3	14.2	492.45	0.86	6.71	93.76
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg						0.86		74.84

TEST DATE: 7/17/01 **TREATMENT: Tacking Agent 3** **SOIL TYPE:** **SLOPE: 2:1**

TEST TIME: 9:00a **REPLICATE NUMBER: 1** **STORM TYPE: 10yr-2** **TEST CREW:**

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	3.6	gallons	9.11	kg	74	8.9	33.5	10.5	1437.50	0.40	5.73	19.36
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg								
PERIOD 2	1	5 gal / 32 gal	500	19	gallons	25.09	kg	66	8.9	85.7	68.1	29.73	16.54	5.07	76.98
	2	5 gal / 32 gal			gallons	12.86	kg	6	11.2	65.1	45.5	57.14	7.55	4.31	4.31
	3	5 gal / 32 gal			gallons	14.61	kg	31	11.2	64.2	27.3	229.19	4.13	9.48	9.48
	4	5 gal / 32 gal	500	22.9	gallons	27.1	kg	54	12.1	87.8	69.5	31.88	17.79	5.83	92.51
	5	5 gal / 32 gal			gallons	13.84	kg	10	11.1	41.1	18.1	328.57	3.00	9.84	9.84
	6	5 gal / 32 gal	500	23.75	gallons	19.75	kg	29	11.1	86.5	69.2	29.78	12.42	3.85	93.74
	7	5 gal / 32 gal			gallons	14.88	kg	72	8.9	30.7	16.5	186.84	4.84	9.04	9.04
	8	5 gal / 32 gal	500	22.6	gallons	18.7	kg	69	8.9	77.7	61	32.05	11.40	3.82	89.36
	9	5 gal / 32 gal			gallons	13.93	kg	44	11	40.7	16.4	450.00	2.35	10.58	10.58
													80.03		395.84
PERIOD 3	1	5 gal / 32 gal	500	23	gallons	14.43	kg	63	8.9	56.2	34.3	86.22	5.65	5.30	92.36
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg						5.65		73.43

TEST DATE: 7/18/01 **TREATMENT: Tacking Agent 3** **SOIL TYPE:** **SLOPE: 2:1**

TEST TIME: 9:00a **REPLICATE NUMBER: 2** **STORM TYPE: 10yr-2** **TEST CREW:**

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	14.25	gallons	9.49	kg	60	12.2	60.8	34.5	117.94	2.99	3.52	57.46
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg								
PERIOD 2	1	5 gal / 32 gal	500	20	gallons	19.4	kg	79	8.9	79.2	57.8	43.76	10.92	5.00	80.70
	2	5 gal / 32 gal			gallons	7.27	kg	5	11.1	47.4	17.5	467.19	1.11	5.16	5.16
	3	5 gal / 32 gal	500	23	gallons	15.19	kg	67	8.8	75.2	60.6	28.19	9.03	2.68	89.74
	4	5 gal / 32 gal			gallons	11.89	kg	58	12.1	43.2	18.7	371.21	2.31	8.58	8.58
	5	5 gal / 32 gal	500	22	gallons	14.27	kg	104	10.7	64.8	52	30.99	8.12	2.67	85.94
	6	5 gal / 32 gal			gallons	13.76	kg	19	10	38.3	15.3	433.96	2.39	10.37	10.37
	7	5 gal / 32 gal	500	23	gallons	13.44	kg	84	8.8	84.2	67.5	28.45	7.64	2.32	89.37
	8	5 gal / 32 gal			gallons	12.1	kg	15	10.9	47	18.4	381.33	2.31	8.79	8.79
													43.82		378.66
PERIOD 3	1	5 gal / 32 gal	500	24	gallons	11.69	kg	51	12	55.4	26.8	193.24	2.47	5.74	96.58
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg						2.47		77.65

TEST DATE: 7/31/01 **TREATMENT: Top Coat** **SOIL TYPE: fine graded** **SLOPE: 2:1**

TEST TIME: 10:00 am **REPLICATE NUMBER: 1** **STORM TYPE: 10yr-2** **TEST CREW: bill, chris, sung**

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	0.5	gallons	0	kg								1.89
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg								
PERIOD 2	1	5 gal / 32 gal	500	3.5	gallons	0	kg								13.25
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal	500	13.75	gallons	12.39	kg	66	8.9	52	22	229.01	2.36	6.55	58.59
	4	5 gal / 32 gal			gallons		kg								
	5	5 gal / 32 gal	500	21	gallons	12.36	kg	104	10.7	48.5	24.7	170.00	2.97	5.91	85.39
	6	5 gal / 32 gal			gallons		kg								
	7	5 gal / 32 gal	500	21.25	gallons	12.56	kg	29	11.1	56.5	32.7	110.19	4.06	5.02	85.45
	8	5 gal / 32 gal			gallons		kg								
													9.39		242.69
PERIOD 3	1	5 gal / 32 gal	500	23.75	gallons	9	kg	6	11.2	59.5	26.8	209.62	1.44	4.08	93.97
	2	5 gal / 32 gal			gallons		kg						1.44		75.04
	3	5 gal / 32 gal			gallons		kg								

TEST DATE: 8/01/01 **TREATMENT: Top Coat** **SOIL TYPE: fine graded** **SLOPE: 2:1**

TEST TIME: 11:00 am **REPLICATE NUMBER: 2** **STORM TYPE: 10yr-2** **TEST CREW: bill, chris, sung**

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	4.25	gallons	5.73	kg	74	8.9	43.8	10.2	2584.62	0.10	2.65	18.73
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg								
PERIOD 2	1	5 gal / 32 gal	500	15.5	gallons	8.1	kg	79	8.9	62.9	43.8	54.73	2.81	1.81	60.48
	2	5 gal / 32 gal			gallons	6.03	kg	15	10.9	48.3	17.1	503.23	0.83	4.20	4.20
	3	5 gal / 32 gal	500	20	gallons	9.9	kg	63	9	68.6	43.9	70.77	3.55	2.87	78.57
	4	5 gal / 32 gal			gallons	6.13	kg	69	8.9	40.4	14	517.65	0.83	4.30	4.30
	5	5 gal / 32 gal	500	20.5	gallons	9.51	kg	131	11	81.5	63.4	34.54	4.35	1.68	79.27
	6	5 gal / 32 gal			gallons	6.19	kg	56	12.2	41.5	16.8	536.96	0.81	4.38	4.38
	7	5 gal / 32 gal	500	21	gallons	9.49	kg	72	8.9	72.6	47.7	64.18	3.47	2.54	82.03
	8	5 gal / 32 gal			gallons	5.95	kg	14	11.3	44.3	18.1	385.29	1.02	3.93	3.93
													17.68		317.15
PERIOD 3	1	5 gal / 32 gal	500	22.75	gallons	8.25	kg	67	8.8	53.1	29.6	112.98	1.97	2.80	88.90
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg						1.97		69.98

TEST DATE: 8/14/01 **TREATMENT: Bare Soil** **SOIL TYPE: coarse graded** **SLOPE: 2:1**

TEST TIME: 1:00 p **REPLICATE NUMBER: 1** **STORM TYPE: 10yr-2** **TEST CREW: chris, sung**

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	0.5	gallons	0	kg								1.89
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg								
PERIOD 2	1	5 gal / 32 gal	500	13.5	gallons	15	kg	44	11	63.4	39.4	84.51	6.01	5.51	56.60
	2	5 gal / 32 gal			gallons	12.24	kg	5	11.1	44.6	18.8	335.06	2.58	8.66	8.66
	3	5 gal / 32 gal	500	18	gallons	12.24	kg	101	11.5	84.9	61	48.28	5.74	3.02	71.15
	4	5 gal / 32 gal			gallons	11.99	kg	84	8.8	35.4	15.6	291.18	2.81	8.18	8.18
	5	5 gal / 32 gal	500	18.5	gallons	12.24	kg	10	11.1	69.8	48.3	57.80	5.37	3.39	73.41
	6	5 gal / 32 gal			gallons	9.75	kg	58	12.1	47.3	20.6	314.12	2.11	6.64	6.64
	7	5 gal / 32 gal	500	18.3	gallons	11.02	kg	81	8.9	70.8	52.9	40.68	5.22	2.32	71.59
	8	5 gal / 32 gal			gallons	9.7	kg	59	12	46.5	21	283.33	2.27	6.43	6.43
													32.12		302.66
PERIOD 3	1	5 gal / 32 gal	500	17.5	gallons	11.73	kg	60	12.1	51.4	22.4	281.55	1.79	6.46	72.69
	2	5 gal / 32 gal			gallons		kg						1.79		53.77
	3	5 gal / 32 gal			gallons		kg								

TEST DATE: 8/15/01 **TREATMENT: Bare Soil** **SOIL TYPE: coarse graded** **SLOPE: 2:1**

TEST TIME: 1:00 p **REPLICATE NUMBER: 2** **STORM TYPE: 10yr-2** **TEST CREW: chris, sung**

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	10.5	gallons	7.21	kg	9	10.8	47.7	16.2	583.33	0.62	3.61	43.35
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg								
PERIOD 2	1	5 gal / 32 gal	500	18	gallons	8.26	kg	69	8.9	63.9	44.9	52.78	2.96	1.82	69.95
	2	5 gal / 32 gal			gallons	12.36	kg	51	12.1	44.6	17.5	501.85	1.89	9.47	9.47
	3	5 gal / 32 gal	500	20	gallons	10.14	kg	72	8.9	57.1	34.4	89.02	3.29	3.37	79.07
	4	5 gal / 32 gal			gallons	6.13	kg	104	10.7	40.7	16.8	391.80	1.04	4.09	4.09
	5	5 gal / 32 gal	500	19	gallons	7.75	kg	29	11.1	63.6	45.2	53.96	2.60	1.67	73.59
	6	5 gal / 32 gal			gallons	10.42	kg	50	12	50.3	19.5	410.67	1.84	7.58	7.58
	7	5 gal / 32 gal	500	20	gallons	7.23	kg	53	12	68.6	48.1	56.79	2.21	1.54	77.24
	8	5 gal / 32 gal			gallons	7.91	kg	64	9	36	16	285.71	1.79	5.12	5.12
													17.62		326.11
PERIOD 3	1	5 gal / 32 gal	500	18.75	gallons	8.14	kg	65	8.8	49.7	19.3	289.52	0.82	3.84	74.80
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg						0.82		55.88

TEST DATE: 9/5/01 **TREATMENT: Earthguard** **SOIL TYPE: coarse graded** **SLOPE: 2:1**

TEST TIME: 1:00 p **REPLICATE NUMBER: 1** **STORM TYPE: 10yr-2** **TEST CREW: bill, sung**

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	1	liters / **gal**	0	g / **kg**								3.79
	2	5 gal / 32 gal			liters / gal		g / kg								
	3	5 gal / 32 gal			liters / gal		g / kg								
PERIOD 2	1	5 gal / 32 gal	500	5.25	liters / **gal**	5.02	g / **kg**	31	11.3	43.7	15.3	710.00	0.02	1.52	21.39
	2	5 gal / 32 gal			liters / gal		g / **kg**								
	3	5 gal / 32 gal	500	21	liters / **gal**	6.29	g / **kg**	44	11	51	14.8	952.63	0.01	2.80	82.29
	4	5 gal / 32 gal			liters / gal		g / **kg**								
	5	5 gal / 32 gal	500	23.6	liters / **gal**	6.47	g / **kg**	104	10.7	49.3	15.7	672.00	0.03	2.96	92.29
	6	5 gal / 32 gal			liters / gal		g / **kg**								
	7	5 gal / 32 gal	500	24	liters / **gal**	8.62	g / **kg**	10	11.1	45	16.1	578.00	0.02	5.12	95.96
	8	5 gal / 32 gal			liters / gal		g / **kg**								
													0.08		291.92
PERIOD 3	1	5 gal / 32 gal	500	30	liters / **gal**	7.4	g / **kg**	80	8.8	43.7	10.9	1561.90	0.02	3.90	117.45
	2	5 gal / 32 gal			liters / gal		g / **kg**						0.02		98.53
	3	5 gal / 32 gal			liters / gal		g / kg								

TEST DATE: 9/6/01 **TREATMENT: Earthguard** **SOIL TYPE: coarse graded** **SLOPE: 2:1**

TEST TIME: 1:00 p **REPLICATE NUMBER: 2** **STORM TYPE: 10yr-2** **TEST CREW: billy, sung**

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	3.15	liters / **gal**		g / **kg**								11.92
	2	5 gal / 32 gal			liters / gal		g / kg								
	3	5 gal / 32 gal			liters / gal		g / kg								
PERIOD 2	1	5 gal / 32 gal	500	16.5	liters / **gal**	5.05	g / **kg**	52	12	49.6	14.5	1404.00	0.02	1.55	64.00
	2	5 gal / 32 gal			liters / gal		g / **kg**								
	3	5 gal / 32 gal	500	22.5	liters / **gal**	6.38	g / **kg**	74	8.9	41.7	9.3	8100.00	0.02	2.88	88.04
	4	5 gal / 32 gal			liters / gal		g / **kg**								
	5	5 gal / 32 gal	500	23	liters / **gal**	6.69	g / **kg**	14	12	45.8	11.6	-8550.00	0.03	3.18	90.24
	6	5 gal / 32 gal			liters / gal		g / **kg**								
	7	5 gal / 32 gal	500	23	liters / **gal**	4.9	g / **kg**	54	12.1	50	15.6	982.86	0.01	1.41	88.47
	8	5 gal / 32 gal			liters / gal		g / **kg**								
													0.08		330.75
PERIOD 3	1	5 gal / 32 gal	500	30	liters / **gal**	5.51	g / **kg**	58	12.9	50.2	21.4	338.82	0.08	1.95	115.50
	2	5 gal / 32 gal			liters / gal		g / **kg**								
	3	5 gal / 32 gal			liters / gal		g / kg						0.08		96.58

TEST DATE: 8/16/01 **TREATMENT: Soil Sement** **SOIL TYPE: coarse graded** **SLOPE: 2:1**

TEST TIME: 1:00 pm **REPLICATE NUMBER: 1** **STORM TYPE: 10yr-2** **TEST CREW: Chris, Sung**

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	0.75	gallons	0	kg								2.84
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg								
PERIOD 2	1	5 gal / 32 gal	500	13.5	gallons	6.83	kg	64	8.9	71.3	47.8	60.41	1.90	1.45	52.55
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal	500	20	gallons	8.65	kg	72	8.9	71.8	49.9	53.41	3.20	1.97	77.67
	4	5 gal / 32 gal			gallons		kg								
	5	5 gal / 32 gal	500	20	gallons	8.57	kg	9	10.8	70.8	47.9	61.73	2.96	2.13	77.83
	6	5 gal / 32 gal			gallons		kg								
	7	5 gal / 32 gal	500	21.5	gallons	9.26	kg	29	11.1	70.4	45.2	73.90	3.11	2.67	84.05
	8	5 gal / 32 gal			gallons		kg								
													11.16		292.10
PERIOD 3	1	5 gal / 32 gal	500	21.5	gallons	6.95	kg	51	12	60.8	32.7	135.75	1.18	2.29	83.66
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg						1.18		64.74

TEST DATE: 8/17/01 **TREATMENT: Soil Sement** **SOIL TYPE: coarse graded** **SLOPE: 2:1**

TEST TIME: 1:00 pm **REPLICATE NUMBER: 2** **STORM TYPE: 10yr-2** **TEST CREW: Chris, Sung**

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	10.5	gallons	4.59	kg	74	8.9	48.1	12.6	959.46	0.15	1.46	41.20
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg								
PERIOD 2	1	5 gal / 32 gal	500	19.75	gallons	9.02	kg	79	8.9	68.4	42.4	77.61	2.90	2.64	77.39
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal	500	21	gallons	8.1	kg	14	8.9	79.2	53.5	57.62	2.75	1.87	81.36
	4	5 gal / 32 gal			gallons		kg								
	5	5 gal / 32 gal	500	20	gallons	9.54	kg	67	8.7	71.3	48.2	58.48	3.64	2.42	78.12
	6	5 gal / 32 gal			gallons		kg								
	7	5 gal / 32 gal	500	21.5	gallons	7.19	kg	56	9.6	84.4	57.3	56.81	2.18	1.53	82.90
	8	5 gal / 32 gal			gallons		kg								
													11.47		319.77
PERIOD 3	1	5 gal / 32 gal	500	22	gallons	5.32	kg	54	12.1	76.9	51.3	65.31	0.92	0.92	84.19
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg						0.92		65.27

TEST DATE: 9/12/01 **TREATMENT: Airtrol** **SOIL TYPE: coarse graded** **SLOPE: 2:1**

TEST TIME: 10:00 am **REPLICATE NUMBER: 1** **STORM TYPE: 10yr-2** **TEST CREW: Chris, Sung**

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	6.55	liters / **gal**	5.75	g / **kg**	54	12.1	51.1	13.2	3445.45	0.02	2.25	27.04
	2	5 gal / 32 gal			liters / gal		g / kg								
	3	5 gal / 32 gal			liters / gal		g / kg								
PERIOD 2	1	5 gal / 32 gal	500	22.6	liters / **gal**	9.25	g / **kg**	9	10.9	48.1	22.1	232.14	1.39	4.38	89.92
	2	5 gal / 32 gal			liters / gal		g / **kg**								
	3	5 gal / 32 gal	500	24.75	liters / **gal**	9.54	g / **kg**	80	9.1	52.5	19.3	325.49	1.04	5.02	98.70
	4	5 gal / 32 gal			liters / gal		g / **kg**								
	5	5 gal / 32 gal	500	25	liters / **gal**	10.31	g / **kg**	6	11.2	56.6	19.6	440.48	0.86	5.97	100.60
	6	5 gal / 32 gal			liters / gal		g / **kg**								
	7	5 gal / 32 gal	500	24.5	liters / **gal**	10.1	g / **kg**	69	8.9	45.4	15	498.36	0.69	5.93	98.66
	8	5 gal / 32 gal			liters / gal		g / **kg**								
													3.98		387.88
PERIOD 3	1	5 gal / 32 gal	500	26.5	liters / **gal**	7.25	g / **kg**	58	12.1	49.2	16.1	827.50	0.02	3.75	104.05
	2	5 gal / 32 gal			liters / gal		g / **kg**								
	3	5 gal / 32 gal			liters / gal		g / kg						0.02		85.13

TEST DATE: 9/13/01 | TREATMENT: Airtrol | SOIL TYPE: coarse graded | SLOPE: 2:1

TEST TIME: 10:00 am | REPLICATE NUMBER: 2 | STORM TYPE: 10yr-2 | TEST CREW: Chris, Sung

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	10	liters / **gal**	5.73	g / **kg**	131	11	45.7	12	3370.00	0.02	2.23	40.08
	2	5 gal / 32 gal			liters / gal		g / kg								
	3	5 gal / 32 gal			liters / gal		g / kg								
PERIOD 2	1	5 gal / 32 gal	500	19.25	liters / **gal**	9.24	g / **kg**	51	12.1	50.2	18.8	468.66	0.60	5.16	78.02
	2	5 gal / 32 gal			liters / gal		g / **kg**								
	3	5 gal / 32 gal	500	20.75	liters / **gal**	10.67	g / **kg**	56	12.2	44.3	16.4	664.29	0.51	6.68	85.22
	4	5 gal / 32 gal			liters / gal		g / **kg**								
	5	5 gal / 32 gal	500	21	liters / **gal**	9.96	g / **kg**	74	8.9	51.9	15.1	593.55	0.51	5.97	85.46
	6	5 gal / 32 gal			liters / gal		g / **kg**								
	7	5 gal / 32 gal	500	20.25	liters / **gal**	10.53	g / **kg**	31	11.2	37.7	15.4	530.95	0.70	6.35	83.00
	8	5 gal / 32 gal			liters / gal		g / **kg**								
													2.31		331.70
PERIOD 3	1	5 gal / 32 gal	500	24	liters / **gal**	6.85	g / **kg**	44	11	42	13.5	1140.00	0.03	3.34	94.18
	2	5 gal / 32 gal			liters / gal		g / **kg**								
	3	5 gal / 32 gal			liters / gal		g / kg						0.03		75.26

TEST DATE: 9/8/01 **TREATMENT: Ultra Tack** **SOIL TYPE: coarse graded** **SLOPE: 2:1**

TEST TIME: 1:00 p **REPLICATE NUMBER: 1** **STORM TYPE: 10yr-2** **TEST CREW: chris, sung**

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	1.75	liters / **gal**	0	g / **kg**								6.62
	2	5 gal / 32 gal			liters / gal		g / kg								
	3	5 gal / 32 gal			liters / gal		g / kg								
PERIOD 2	1	5 gal / 32 gal	500	12.5	liters / **gal**	4.72	g / **kg**	81	9.1	61.3	30.3	146.23	0.21	1.03	48.35
	2	5 gal / 32 gal			liters / gal		g / **kg**								
	3	5 gal / 32 gal	500	25	liters / **gal**	4.03	g / **kg**	52	12.2	72.3	41.8	103.04	0.02	0.53	95.16
	4	5 gal / 32 gal			liters / gal		g / **kg**								
	5	5 gal / 32 gal	500	25.5	liters / **gal**	4.12	g / **kg**	35	11.3	57.7	27.6	184.66	0.02	0.62	97.14
	6	5 gal / 32 gal			liters / gal		g / **kg**								
	7	5 gal / 32 gal	500	24.5	liters / **gal**	4.62	g / **kg**	83	9.2	57.8	31.6	116.96	0.26	0.88	93.62
	8	5 gal / 32 gal			liters / gal		g / **kg**								
													0.50		334.26
PERIOD 3	1	5 gal / 32 gal	500	26.5	liters / **gal**	4.1	g / **kg**	65	9.1	60.1	33.8	106.48	0.04	0.58	100.88
	2	5 gal / 32 gal			liters / gal		g / **kg**								
	3	5 gal / 32 gal			liters / gal		g / kg						0.04		81.96

TEST DATE: 9/9/01 **TREATMENT: Ultra Tack** **SOIL TYPE: coarse graded** **SLOPE: 2:1**

TEST TIME: 1:00 p **REPLICATE NUMBER: 2** **STORM TYPE: 10yr-2** **TEST CREW: chris, sung**

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	6.5	liters / **gal**	5.82	g / **kg**	59	12	47.4	15.9	807.69	0.01	2.33	26.93
	2	5 gal / 32 gal			liters / gal		g / kg								
	3	5 gal / 32 gal			liters / gal		g / kg								
PERIOD 2	1	5 gal / 32 gal	500	18.25	liters / **gal**	8	g / **kg**	79	9	50.7	17.4	396.43	0.51	4.01	73.09
	2	5 gal / 32 gal			liters / gal		g / **kg**								
	3	5 gal / 32 gal	500	22	liters / **gal**	6.2	g / **kg**	19	10.1	45	11.4	2584.62	0.02	2.70	85.97
	4	5 gal / 32 gal			liters / gal		g / **kg**								
	5	5 gal / 32 gal	500	24	liters / **gal**	5.61	g / **kg**	67	8.8	47.7	18.2	313.83	0.14	1.99	92.83
	6	5 gal / 32 gal			liters / gal		g / **kg**								
	7	5 gal / 32 gal	500	23.8	liters / **gal**	7.09	g / **kg**	10	11.4	48.3	16.2	668.75	0.03	3.58	93.66
	8	5 gal / 32 gal			liters / gal		g / **kg**								
													0.70		345.55
PERIOD 3	1	5 gal / 32 gal	500	25	liters / **gal**	9.15	g / **kg**	6	8.9	41	9.7	3912.50	0.02	5.65	100.28
	2	5 gal / 32 gal			liters / gal		g / **kg**								
	3	5 gal / 32 gal			liters / gal		g / kg						0.02		81.35

TEST DATE: 8/28/01 **TREATMENT: PAM** **SOIL TYPE: coarse graded** **SLOPE: 2:1**

TEST TIME: 9:00 am **REPLICATE NUMBER: 1** **STORM TYPE: 10yr-2** **TEST CREW: chris, sung**

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	4.25	liters / **gal**	4.33	g / **kg**	131	11.2	43	11.8	5200.00	0.03	1.32	17.41
	2	5 gal / 32 gal			liters / gal		g / kg								
	3	5 gal / 32 gal			liters / gal		g / kg								
PERIOD 2	1	5 gal / 32 gal	500	26.5	liters / **gal**	11.24	g / **kg**	66	8.9	49.9	34	63.35	4.56	3.20	103.51
	2	5 gal / 32 gal			liters / gal	11.78	g / **kg**	79	9	45.3	25.8	116.07	4.99	5.79	5.79
	3	5 gal / 32 gal	500	19	liters / **gal**	9.91	g / **kg**	51	12.1	62.2	40.6	75.79	3.44	2.99	74.90
	4	5 gal / 32 gal			liters / gal	8.32	g / **kg**	19	10.1	32.4	16.4	253.97	2.07	5.25	5.25
	5	5 gal / 32 gal	500	18.5	liters / **gal**	12.6	g / **kg**	67	8.8	75.4	51.9	54.52	5.73	3.39	73.42
	6	5 gal / 32 gal			liters / gal	8.22	g / **kg**	29	11.2	40.9	17.9	343.28	1.63	5.59	5.59
	7	5 gal / 32 gal	500	17.5	liters / **gal**	11.47	g / **kg**	16	11.4	82.3	51.5	76.81	4.30	3.69	69.93
	8	5 gal / 32 gal			liters / gal	11.39	g / **kg**	83	9	38.1	14.7	410.53	2.04	8.35	8.35
													28.75		346.74
PERIOD 3	1	5 gal / 32 gal	500	20.75	liters / **gal**	10.31	g / **kg**	50	12	46.9	22.6	229.25	1.73	5.10	83.64
	2	5 gal / 32 gal			liters / gal		g / **kg**						1.73		64.72
	3	5 gal / 32 gal			liters / gal		g / kg								

TEST DATE: 8/29/01 | TREATMENT: PAM | SOIL TYPE: coarse graded | SLOPE: 2:1

TEST TIME: 9:00 am | REPLICATE NUMBER: 2 | STORM TYPE: 10yr-2 | TEST CREW: chris, sung

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	9	liters / **gal**	8.86	g / **kg**	65	8.9	42.1	12.7	773.68	0.67	5.21	39.27
	2	5 gal / 32 gal			liters / gal		g / kg								
	3	5 gal / 32 gal			liters / gal		g / kg								
PERIOD 2	1	5 gal / 32 gal	500	16.5	liters / **gal**	11.4	g / **kg**	69	8.8	67.6	44.8	63.33	4.66	3.26	65.72
	2	5 gal / 32 gal			liters / gal	12.34	g / **kg**	35	11.1	47.4	19.7	322.09	2.69	8.65	8.65
	3	5 gal / 32 gal	500	18.5	liters / **gal**	10.87	g / **kg**	14	11.3	72.9	48.9	63.83	4.32	3.07	73.10
	4	5 gal / 32 gal			liters / gal	8.71	g / **kg**	81	8.9	38.5	16.6	284.42	2.01	5.70	5.70
	5	5 gal / 32 gal	500	19	liters / **gal**	10.28	g / **kg**	9	10.8	78.6	51.8	65.37	3.91	2.89	74.80
	6	5 gal / 32 gal			liters / gal	8.4	g / **kg**	63	8.9	43.5	18	280.22	1.95	5.45	5.45
	7	5 gal / 32 gal	500	19	liters / **gal**	8.2	g / **kg**	59	12	76	50.5	66.23	2.64	2.08	73.99
	8	5 gal / 32 gal			liters / gal	10.66	g / **kg**	52	12	52.3	24	235.83	2.88	6.78	6.78
													25.04		314.20
PERIOD 3	1	5 gal / 32 gal	500	17.3	liters / **gal**	10.21	g / **kg**	61	11.9	51.2	19.1	445.83	0.82	5.91	71.39
	2	5 gal / 32 gal			liters / gal		g / **kg**								
	3	5 gal / 32 gal			liters / gal		g / kg						0.82		52.46

TEST DATE: 8/21/01 **TREATMENT: Tacking Agent 3** **SOIL TYPE: coarse graded** **SLOPE: 2:1**

TEST TIME: 9:00a **REPLICATE NUMBER: 1** **STORM TYPE: 10yr-2** **TEST CREW:**

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	5	gallons	0	kg								18.93
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg								
PERIOD 2	1	5 gal / 32 gal	500	16.75	gallons	15.85	kg	5	11.2	74.2	47.3	74.52	6.87	5.50	68.89
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg								
	4	5 gal / 32 gal	500	18.5	gallons	15.51	kg	79	9.2	57.7	27.9	159.36	4.33	7.70	77.72
	5	5 gal / 32 gal			gallons		kg								
	6	5 gal / 32 gal	500	21	gallons	20.1	kg	104	11	73	48.3	66.22	9.80	6.82	86.31
	7	5 gal / 32 gal			gallons		kg								
	8	5 gal / 32 gal	500	21.25	gallons	18.71	kg	44	11.3	80.7	53.1	66.03	8.97	6.26	86.69
	9	5 gal / 32 gal			gallons		kg								
													29.98		319.61
PERIOD 3	1	5 gal / 32 gal	500	20	gallons	10.1	kg	59	12.3	73.3	46.6	77.84	3.50	3.12	78.82
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg						3.50		59.89

TEST DATE: 8/22/01 **TREATMENT: Tacking Agent 3** **SOIL TYPE: coarse graded** **SLOPE: 2:1**

TEST TIME: 9:00a **REPLICATE NUMBER: 2** **STORM TYPE: 10yr-2** **TEST CREW:**

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	11	gallons	4.83	kg	131	11	44	20.5	247.37	0.53	1.32	42.95
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg								
PERIOD 2	1	5 gal / 32 gal	500	21.25	gallons	13.97	kg	31	11.3	62.9	40.2	78.55	5.66	4.83	85.27
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal	500	22.25	gallons	12.38	kg	60	12.1	59.2	38.4	79.09	4.75	4.15	88.37
	4	5 gal / 32 gal			gallons		kg								
	5	5 gal / 32 gal	500	22.25	gallons	15.3	kg	52	12	57.6	32.4	123.53	5.01	6.81	91.02
	6	5 gal / 32 gal			gallons		kg								
	7	5 gal / 32 gal	500	22	gallons	12.95	kg	83	8.9	49	28.1	108.85	4.27	5.20	88.47
	8	5 gal / 32 gal			gallons		kg								
													19.69		353.12
PERIOD 3	1	5 gal / 32 gal	500	12	gallons	6.05	kg	58	12.2	50.9	21.3	325.27	0.22	2.35	47.77
	2	5 gal / 32 gal			gallons		kg								
	3	5 gal / 32 gal			gallons		kg						0.22		28.84

TEST DATE: 8/30/01 **TREATMENT: Top Coat** **SOIL TYPE: coarse graded** **SLOPE: 2:1**

TEST TIME: 10:00 am **REPLICATE NUMBER: 1** **STORM TYPE: 10yr-2** **TEST CREW: bill, chris, sung**

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	0.5	liters / **gal**	0	g / **kg**								1.89
	2	5 gal / 32 gal			liters / gal		g / kg								
	3	5 gal / 32 gal			liters / gal		g / kg								
PERIOD 2	1	5 gal / 32 gal	500	6	liters / **gal**	8.19	g / **kg**	54	12.1	42	15.8	708.11	0.14	4.57	27.28
	2	5 gal / 32 gal			liters / gal		g / **kg**								
	3	5 gal / 32 gal	500	17.5	liters / **gal**	11.66	g / **kg**	60	12.1	56	28	176.10	2.64	5.54	71.77
	4	5 gal / 32 gal			liters / gal		g / **kg**								
	5	5 gal / 32 gal	500	18.8	liters / **gal**	12.28	g / **kg**	72	8.9	48.9	21.4	220.00	2.41	6.39	77.55
	6	5 gal / 32 gal			liters / gal		g / **kg**								
	7	5 gal / 32 gal	500	19	liters / **gal**	13.41	g / **kg**	6	11.2	57.1	27.5	181.60	3.20	6.73	78.64
	8	5 gal / 32 gal			liters / gal		g / **kg**								
													8.40		255.24
PERIOD 3	1	5 gal / 32 gal	500	19	liters / **gal**	8.71	g / **kg**	5	11.1	49.1	15.3	804.76	0.13	5.10	77.01
	2	5 gal / 32 gal			liters / gal		g / **kg**						0.13		58.09
	3	5 gal / 32 gal			liters / gal		g / kg								

TEST DATE: 8/31/01 **TREATMENT: Top Coat** **SOIL TYPE: coarse graded** **SLOPE: 2:1**

TEST TIME: 11:00 am **REPLICATE NUMBER: 2** **STORM TYPE: 10yr-2** **TEST CREW: bill, chris, sung**

		BUCKET TYPE	Gypsum Weight (grams)	SUPERNATANT VOLUME	(units)	TOTAL BUCKET WEIGHT: bucket+sediment just before MC test	(units)	Wo Can Number	Wo Can weight	Wet Wt. Can+sediment	Dry Wt. Can+sediment	Wo	Sed. Wt.	Wat. Wt.	Runoff(L)
PERIOD 1	1	5 gal / 32 gal	0	6.5	liters / **gal**	4.62	g / **kg**	15	11	37.4	11.9	2833.33	0.06	1.58	26.19
	2	5 gal / 32 gal			liters / gal		g / kg								
	3	5 gal / 32 gal			liters / gal		g / kg								
PERIOD 2	1	5 gal / 32 gal	500	16.75	liters / **gal**	12.98	g / **kg**	84	8.8	52.9	19.6	308.33	1.95	7.55	70.95
	2	5 gal / 32 gal			liters / gal		g / **kg**								
	3	5 gal / 32 gal	500	19	liters / **gal**	12.48	g / **kg**	58	12.2	59.4	27	218.92	2.48	6.52	78.44
	4	5 gal / 32 gal			liters / gal		g / **kg**								
	5	5 gal / 32 gal	500	19.25	liters / **gal**	12.69	g / **kg**	56	12.2	57.5	23.7	293.91	1.97	7.24	80.11
	6	5 gal / 32 gal			liters / gal		g / **kg**								
	7	5 gal / 32 gal	500	19.25	liters / **gal**	12.16	g / **kg**	74	8.9	57.5	24.8	205.66	2.50	6.18	79.04
	8	5 gal / 32 gal			liters / gal		g / **kg**								
													8.90		308.53
PERIOD 3	1	5 gal / 32 gal	500	19.5	liters / **gal**	7.31	g / **kg**	64	9	50.6	15.6	530.30	0.19	3.64	77.45
	2	5 gal / 32 gal			liters / gal		g / **kg**								
	3	5 gal / 32 gal			liters / gal		g / kg						0.19		58.53

Test Material: Bare Soil

Application Rate: N/A

TPSSES Storm Event

Parameter	Description	Units	EPA Test Number	55S/12-201 February 12,2001 coarse	55S/12-201 February 24-26,2001 coarse	55S/12-201 March 6,2001 coarse	55S/12-201 April 7,2001 coarse
				Site/Plot Date Soil Type			
pH		pH units	150.1	9.2	8.7	C	C
EC	Specifc Conductivity	umhos/cm	120.1	345	129	C	C
TSS	Total Susspended Solids	mg/L	160.2	8119	9581	C	C
TDS	Total Dissolved Solids	mg/L	160.1	522	208	C	C
Hardness	as $CaCO_3$	mg/L	130.2	265	114	C	C
BOD	Biological Oxygen Demand	mg/L	405.1	A	A	C	C
COD	Chemical Oxygen Demand	mg/L	410.4	A	A	C	C
DOC	Dissolved Organic Carbon	mg/L	415.1	33	18	C	C
TOC	Total Organic Carbon	mg/L	415.1	38	20	C	C
NO_3	as Nitrogen	mg/L	300.0	1.2	0.3	C	C
TKN	Total Kjedahl Nitrogen	mg/L	351.3	7.1	1.5	C	C
P	Phosphorous	mg/L	365.2	0.16	5.25	C	C
Ortho-P	Dissolved Ortho-Phosphate	mg/L	365.2	0.09	< 0.03	C	C
NH_3-N	Ammonia	mg/L	350.2	0.27	0.1	C	C
$S0_4$	Sulfate	mg/L	300.0	45	10	C	C
TPH	Heavy Oil	mg/L	8015DRO	< 50	< 50	C	C
NO_2	Nitrite	mg/L	A	A	A	C	C
Al	Aluminum	ug/L	A	A	A	C	C
As	Arsenic	ug/L	200.8	20	26	C	C
Ba	Barium	ug/L	A	A	A	C	C
Ca	Calcium	ug/L	200.8	601000	543000	C	C
Cd	Cadmium	ug/L	200.8	4.1	3.5	C	C
Cr	Chromium	ug/L	200.8	144	195	C	C
Cu	Copper	ug/L	200.8	198	210	C	C
Fe	Iron	ug/L	200.7	71900	240000	C	C
Hg	Mercury	ng/L	**1631	1230	1700	C	C
K	Potassium	ug/L	200.7	39100	47600	C	C
Li	Lithium	ug/L	A	A	A	C	C
Mg	Magnesium	ug/L	200.7	90400	137000	C	C
Na	Sodium	ug/L	200.7	104000	45800	C	C
Ni	Nickel	ug/L	200.8	168	183	C	C
Pb	Lead	ug/L	200.8	209	206	C	C
Tl	Thallium	ug/L	A	A	A	C	C
V	Vanadium	ug/L	A	A	A	C	C
Zn	Zinc	ug/L	200.8	774	729	C	C
Al	Dissolved Aluminum	ug/L	A	A	A	C	C
As	Dissolved Arsenic	ug/L	200.8	19	18	C	C
Ba	Dissolved Barium	ug/L	A	A	A	C	C
Ca	Dissolved Calcium	ug/L	200.7	26200	494000	C	C
Cd	Dissolved Cadmium	ug/L	200.8	1.8	0.4	C	C
Cr	Dissolved Chromium	ug/L	200.8	141	41	C	C
Cu	Dissolved Copper	ug/L	200.8	108	36	C	C
Fe	Dissolved Iron	ug/L	200.7	9850	49900	C	C
Hg	Dissolved Mercury	ng/L	**1631	840	1400	C	C
K	Dissolved Potassium	ug/L	200.7	8720	8310	C	C
Li	Dissolved Lithium	ug/L	A	A	A	C	C
Mg	Dissolved Magnesium	ug/L	200.7	5160	16900	C	C
Na	Dissolved Sodium	ug/L	200.7	80600	36000	C	C
Ni	Dissolved Nickel	ug/L	200.8	98	26	C	C
Pb	Dissolved Lead	ug/L	200.8	96	27	C	C
Tl	Dissolved Thallium	ug/L	A	A	A	C	C
V	Dissolved Vanadium	ug/L	A	A	A	C	C
Zn	Dissolved Zinc	ug/L	200.8	549	119	C	C
Plot Size	Plot Size	Hectares		0.247104	0.247104	C	C
Rainfall Depth	Depth of Rainfall	mm		35.81	48.01	C	C
Rainfall Duration	Duration of Storm Event	min		720	2880	C	C
Runoff Volume	Volume of Water Collected	L		D	D	C	C
Sediment Capture	Weight of Sediment Collected	kg		A	A	C	C
Total Rate of Sediment Capture	(TSS + Sediment Capture)/Runoff Volume	kg/L		A	A	C	C
Runoff Rate	Runoff Volume / Plot Size	L/Hectare		A	A	C	C
Erosion Rate	Weight of Sediment collected / Plot Size	kg/Hectare		A	A	C	C
Total Erosion Rate	Total Rate of Sediment Capture X Runoff Rate	kg/Hectare		A	A	C	C

S.E.R.L = San Diego State University Soil Erosion Research Laboratory
** = SM Standard
A = Value for parameter not obtained during experiment.
B = No value obtained for parameter because test plots were under construction.
C = Storm Event did not produce sufficient runoff to enable sampling using automated samplers.
D = Below Limit of Detection
N/A = Not Applicable

3.785L = 1gal
1hectare = 2.47104acres
0.454kg = 1lb

Test Material: Bare Soil

Application Rate: N/A

San Diego State University Soil Erosion Reasearch Laboratory Storm Event

Parameter	Description	Units	EPA Test Number	SERL/ 10 Year 1 August 14, 2001 coarse	SERL/10 Year 2 August 15, 2001 coarse	SERL/ 10 Year 1&2 MEAN coarse	SERL/ 10 Year 1 July 11, 2001 fine	SERL/10 Year 2 July 12, 2001 fine	SERL/10 Year 1&2 MEAN fine
				Site/Design Storm Date Soil Type					
pH		pH units	150.1	9.03	8.88	8.955	8.33	8.47	8.40
EC	Specifc Conductivity	umhos/cm	A	A	A	A	A	A	A
TSS	Total Susspended Solids	mg/L	160.2	4200	8306.00	6253	37592.83	17787.58	27690.21
TDS	Total Dissolved Solids	mg/L	A	A	A	A	A	A	A
Hardness	as $CaCO_3$	mg/L	A	A	A	A	A	A	A
BOD	Biological Oxygen Demand	mg/L	405.1	<2.0	127.00	D	4.00	2.67	3.33
COD	Chemical Oxygen Demand	mg/L	A	45	6.00	25.5	30.83	41.33	36.08
DOC	Dissolved Organic Carbon	mg/L	A	A	A	A	A	A	A
TOC	Total Organic Carbon	mg/L	415.2	7.1	2.60	4.85	4.85	3.39	4.12
NO_3	as Nitrogen	mg/L	353.3	0.32	0.42	0.37	0.64	0.27	0.45
TKN	Total Kjedahl Nitrogen	mg/L	351.4	5.98	3.04	4.51	11.32	5.81	8.57
P	Phosphorous	mg/L	365.2	0.49	0.44	0.465	0.18	0.18	0.18
Ortho-P	Dissolved Ortho-Phosphate	mg/L	A	A	A	A	A	A	A
NH_3-N	Ammonia	mg/L	A	A	A	A	A	A	A
$S0_4$	Sulfate	mg/L	A	A	A	A	A	A	A
TPH	Heavy Oil	mg/L	A	A	A	A	A	A	A
NO_2	Nitrite	mg/L	354.1	<0.05	<0.05	D	<0.05	<0.05	D
Al	Aluminum	ug/L	200.7	A	A	A	A	A	A
As	Arsenic	ug/L	206.2	A	A	A	A	A	A
Ba	Barium	ug/L	200.7	A	A	A	A	A	A
Ca	Calcium	ug/L	200.7	A	A	A	A	A	A
Cd	Cadmium	ug/L	200.7	A	A	A	A	A	A
Cr	Chromium	ug/L	200.7	A	A	A	A	A	A
Cu	Copper	ug/L	200.7	A	A	A	A	A	A
Fe	Iron	ug/L	200.7	A	A	A	A	A	A
Hg	Mercury	ng/L	245.1	A	A	A	A	A	A
K	Potassium	ug/L	A	A	A	A	A	A	A
Li	Lithium	ug/L	200.7	A	A	A	A	A	A
Mg	Magnesium	ug/L	200.7	A	A	A	A	A	A
Na	Sodium	ug/L	A	A	A	A	A	A	A
Ni	Nickel	ug/L	200.7	A	A	A	A	A	A
Pb	Lead	ug/L	200.7	A	A	A	A	A	A
Tl	Thallium	ug/L	279.2	A	A	A	A	A	A
V	Vanadium	ug/L	200.7	A	A	A	A	A	A
Zn	Zinc	ug/L	200.7	A	A	A	A	A	A
Al	Dissolved Aluminum	ug/L	200.7	350	300	325	<100	<100	D
As	Dissolved Arsenic	ug/L	206.2	<10	<10	D	<10	<10	D
Ba	Dissolved Barium	ug/L	200.7	420	10	215	26.66666667	20	23.33
Ca	Dissolved Calcium	ug/L	200.7	4800	4600	4700	66750	22625	44687.50
Cd	Dissolved Cadmium	ug/L	200.7	<20	<20	D	<20	<20	D
Cr	Dissolved Chromium	ug/L	200.7	<10	<10	D	20	<10	D
Cu	Dissolved Copper	ug/L	200.7	<10	<10	D	<10	<10	D
Fe	Dissolved Iron	ug/L	200.7	<50	90	D	<50	64.16666667	D
Hg	Dissolved Mercury	ng/L	245.1	<2000	<2000	D	<2000	<2000	D
K	Dissolved Potassium	ug/L	A	A	A	A	A	A	A
Li	Dissolved Lithium	ug/L	200.7	<20	<20	D	<20	<20	D
Mg	Dissolved Magnesium	ug/L	200.7	800	800	800	17123.33333	8165	12644.17
Na	Dissolved Sodium	ug/L	A	A	A	A	A	A	A
Ni	Dissolved Nickel	ug/L	200.7	<40	<40	D	<40	40	D
Pb	Dissolved Lead	ug/L	200.7	<100	<100	D	<100	<100	D
Tl	Dissolved Thallium	ug/L	279.2	<100	<100	D	<100	<100	D
V	Dissolved Vanadium	ug/L	200.7	<20	<20	D	<20	40	D
Zn	Dissolved Zinc	ug/L	200.7	200	30	115	<20	30	D
Plot Size	Plot Size	Hectares		0.0016	0.0016	0.0016	0.0016	0.0016	0.0016
Rainfall Depth	Depth of Rainfall	mm		31.67	31.67	31.67	31.67	31.67	31.67
Rainfall Duration	Duration of Storm Event	min		100	100	100	100	100	100
Runoff Volume	Volume of Water Collected	L		358.32	425.34	391.83	390.65	469.81	430.23
Sediment Capture	Weight of Sediment Collected	kg		33.91	19.05	26.48	45.94	48.46	47.2
Total Rate of Sediment Capture	(TSS + Sediment Capture)/Runoff Volume	kg/L		0.09884	0.05309	0.07596	0.15519	0.12094	0.13806
Runoff Rate	Runoff Volume / Plot Size	L/Hectare		221355.85	262758.14	242056.99	241328.04	290229.94	265778.99
Erosion Rate	Weight of Sediment collected / Plot Size	kg/Hectare		20948.25	11768.33	16358.29	28379.91	29936.66	29158.28
Total Erosion Rate	Total Rate of Sediment Capture X Runoff Rate	kg/Hectare		2070.44	624.82	1347.63	4404.33	3620.41	4012.37

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N/A = Not Applicable

3.785L = 1gal
1hectare = 2.47104acres
0.454kg = 1lb

Test Material: Earthguard

Application Rate: 56.1173 - 65.4702 L/hectare

Parameter	Description	Units	EPA Test Number	TPSSES Storm Event — Site/Plot, Date, Soil Type: 55S/12-202 February 12,2001 coarse	55S/12-202 February 24-26,2001 coarse	55S/12-202 March 6,2001 coarse	55S/12-202 April 7,2001 coarse
pH		pH units	150.1	10.1	9.1	8.2	C
EC	Specifc Conductivity	umhos/cm	120.1	340	154	218	C
TSS	Total Susspended Solids	mg/L	160.2	52	269	72	C
TDS	Total Dissolved Solids	mg/L	160.1	212	156	194	C
Hardness	as $CaCO_3$	mg/L	130.2	57	32	38	C
BOD	Biological Oxygen Demand	mg/L	405.1	A	A	A	C
COD	Chemical Oxygen Demand	mg/L	410.4	A	A	A	C
DOC	Dissolved Organic Carbon	mg/L	415.1	44	21	32	C
TOC	Total Organic Carbon	mg/L	415.1	46	23	34	C
NO_3	as Nitrogen	mg/L	300.0	1.2	< 0.1	0.4	C
TKN	Total Kjedahl Nitrogen	mg/L	351.3	1.7	0.9	1.3	C
P	Phosphorous	mg/L	365.2	0.11	0.43	0.14	C
Ortho-P	Dissolved Ortho-Phosphate	mg/L	365.2	< 0.03	< 0.03	< 0.03	C
NH_3-N	Ammonia	mg/L	350.2	0.12	0.13	0.12	C
SO_4	Sulfate	mg/L	300.0	42	17	40	C
TPH	Heavy Oil	mg/L	8015DRO	< 50	< 50	< 50	C
NO_2	Nitrite	mg/L	A	A	A	A	C
Al	Aluminum	ug/L	A	A	A	A	C
As	Arsenic	ug/L	200.8	6.2	7.4	8.2	C
Ba	Barium	ug/L	A	A	A	A	C
Ca	Calcium	ug/L	200.8	20100	20500	11500	C
Cd	Cadmium	ug/L	200.8	0.3	1.3	0.2	C
Cr	Chromium	ug/L	200.8	2.6	7.9	2.7	C
Cu	Copper	ug/L	200.8	5.7	13	8.1	C
Fe	Iron	ug/L	200.7	390	7260	1430	C
Hg	Mercury	ng/L	**1631	760	1800	1190	C
K	Potassium	ug/L	200.7	8970	7250	5550	C
Li	Lithium	ug/L	A	A	A	A	C
Mg	Magnesium	ug/L	200.7	1140	3590	1600	C
Na	Sodium	ug/L	200.7	53100	35800	45300	C
Ni	Nickel	ug/L	200.8	3.1	6.3	2.6	C
Pb	Lead	ug/L	200.8	< 1	5.3	< 1	C
Tl	Thallium	ug/L	A	A	A	A	C
V	Vanadium	ug/L	A	A	A	A	C
Zn	Zinc	ug/L	200.8	5.3	55	8.4	C
Al	Dissolved Aluminum	ug/L	A	A	A	A	C
As	Dissolved Arsenic	ug/L	200.8	5.5	6.8	7.9	C
Ba	Dissolved Barium	ug/L	A	A	A	A	C
Ca	Dissolved Calcium	ug/L	200.7	19700	8990	11500	C
Cd	Dissolved Cadmium	ug/L	200.8	0.3	0.3	0.2	C
Cr	Dissolved Chromium	ug/L	200.8	2.6	1.5	2.1	C
Cu	Dissolved Copper	ug/L	200.8	5.3	4.8	7.1	C
Fe	Dissolved Iron	ug/L	200.7	160	100	40	C
Hg	Dissolved Mercury	ng/L	**1631	680	1700	1170	C
K	Dissolved Potassium	ug/L	200.7	8500	5820	5010	C
Li	Dissolved Lithium	ug/L	A	A	A	A	C
Mg	Dissolved Magnesium	ug/L	200.7	1140	800	1270	C
Na	Dissolved Sodium	ug/L	200.7	45400	33600	44800	C
Ni	Dissolved Nickel	ug/L	200.8	2.7	<2	2	C
Pb	Dissolved Lead	ug/L	200.8	<1	<1	<1	C
Tl	Dissolved Thallium	ug/L	A	A	A	A	C
V	Dissolved Vanadium	ug/L	A	A	A	A	C
Zn	Dissolved Zinc	ug/L	200.8	5.1	<5	<5	C
Plot Size	Plot Size	Hectares		0.247104	0.247104	0.247104	C
Rainfall Depth	Depth of Rainfall	mm		35.31	47.24	7.87	C
Rainfall Duration	Duration of Storm Event	min		720	2880	360	C
Runoff Volume	Volume of Water Collected	L		7872.57	23702.65	1585.84	C
Sediment Capture	Weight of Sediment Collected	kg		A	A	A	C
Total Rate of Sediment Capture	(TSS + Sediment Capture)/Runoff Volume	kg/L		A	A	A	C
Runoff Rate	Runoff Volume / Plot Size	L/Hectare		31859.33858	95921.75764	6417.702668	C
Erosion Rate	Weight of Sediment collected / Plot Size	kg/Hectare		A	A	A	C
Total Erosion Rate	Total Rate of Sediment Capture X Runoff Rate	kg/Hectare		A	A	A	C

S.E.R.L = San Diego State University Soil Erosion Research Laboratory
** = SM Standard
A = Value for parameter not obtained during experiment.
B = No value obtained for parameter because test plots were under construction.
C = Storm Event did not produce sufficient runoff to enable sampling using automated samplers.
D = Below Limit of Detection
N/A = Not Applicable

3.785L = 1gal
1hectare = 2.47104acres
0.454kg = 1lb

Test Material: Earthguard

Application Rate: 56.1173 - 65.4702 L/hectare

Parameter	Description	Units	EPA Test Number	San Diego State University Soil Erosion Reasearch Laboratory Storm Event — Site/Design Storm, Date, Soil Type: SERL/ 10 Year 1 Sept. 5, 2001 coarse	SERL/10 Year 2 Sept. 6, 2001 coarse	SERL/ 10 Year 1&2 MEAN coarse	SERL/ 10 Year 1 August 7, 2001 fine	SERL/10 Year 2 August 8, 2001 fine	SERL/10 Year 1&2 MEAN fine
pH		pH units	150.1	6.25	7.45	6.85	7.93	8.10	8.02
EC	Specifc Conductivity	umhos/cm	A	A	A	A	A	A	A
TSS	Total Susspended Solids	mg/L	160.2	152	108.00	130	410.00	4518.00	2464.00
TDS	Total Dissolved Solids	mg/L	A	A	A	A	A	A	A
Hardness	as $CaCO_3$	mg/L	A	A	A	A	A	A	A
BOD	Biological Oxygen Demand	mg/L	405.1	446	127.00	286.5	16.70	2.00	9.35
COD	Chemical Oxygen Demand	mg/L	A	658	86.00	372	2500.00	3.70	1251.85
DOC	Dissolved Organic Carbon	mg/L	A	A	A	A	A	A	A
TOC	Total Organic Carbon	mg/L	415.2	182	32.40	107.2	13.40	2.50	7.95
NO_3	as Nitrogen	mg/L	353.3	0.23	0.17	0.2	1.17	0.25	0.71
TKN	Total Kjedahl Nitrogen	mg/L	351.4	34.1	6.72	20.41	3.68	6.10	4.89
P	Phosphorous	mg/L	365.2	0.09	0.11	0.1	0.07	0.06	0.07
Ortho-P	Dissolved Ortho-Phosphate	mg/L	A	A	A	A	A	A	A
NH_3-N	Ammonia	mg/L	A	A	A	A	A	A	A
SO_4	Sulfate	mg/L	A	A	A	A	A	A	A
TPH	Heavy Oil	mg/L	A	A	A	A	A	A	A
NO_2	Nitrite	mg/L	354.1	<0.05	<0.05	D	0.73	<0.05	D
Al	Aluminum	ug/L	200.7	A	A	A	A	A	A
As	Arsenic	ug/L	206.2	A	A	A	A	A	A
Ba	Barium	ug/L	200.7	A	A	A	A	A	A
Ca	Calcium	ug/L	200.7	A	A	A	A	A	A
Cd	Cadmium	ug/L	200.7	A	A	A	A	A	A
Cr	Chromium	ug/L	200.7	A	A	A	A	A	A
Cu	Copper	ug/L	200.7	A	A	A	A	A	A
Fe	Iron	ug/L	200.7	A	A	A	A	A	A
Hg	Mercury	ng/L	245.1	A	A	A	A	A	A
K	Potassium	ug/L	A	A	A	A	A	A	A
Li	Lithium	ug/L	200.7	A	A	A	A	A	A
Mg	Magnesium	ug/L	200.7	A	A	A	A	A	A
Na	Sodium	ug/L	A	A	A	A	A	A	A
Ni	Nickel	ug/L	200.7	A	A	A	A	A	A
Pb	Lead	ug/L	200.7	A	A	A	A	A	A
Tl	Thallium	ug/L	279.2	A	A	A	A	A	A
V	Vanadium	ug/L	200.7	A	A	A	A	A	A
Zn	Zinc	ug/L	200.7	A	A	A	A	A	A
Al	Dissolved Aluminum	ug/L	200.7	320	320	320	600	530	565.00
As	Dissolved Arsenic	ug/L	206.2	10	<10	D	3	<10	D
Ba	Dissolved Barium	ug/L	200.7	40	50	45	60	40	50.00
Ca	Dissolved Calcium	ug/L	200.7	34400	41000	37700	138000	30700	84350.00
Cd	Dissolved Cadmium	ug/L	200.7	<20	<20	D	<20	<20	D
Cr	Dissolved Chromium	ug/L	200.7	<10	<10	D	<10	<10	D
Cu	Dissolved Copper	ug/L	200.7	<10	<10	D	<10	<10	D
Fe	Dissolved Iron	ug/L	200.7	70	<50	D	470	280	375.00
Hg	Dissolved Mercury	ng/L	245.1	<2000	<2000	D	<2000	<2000	D
K	Dissolved Potassium	ug/L	A	A	A	A	A	A	A
Li	Dissolved Lithium	ug/L	200.7	<20	<20	D	<20	<20	D
Mg	Dissolved Magnesium	ug/L	200.7	7230	8100	7665	70800	11100	40950.00
Na	Dissolved Sodium	ug/L	A	A	A	A	A	A	A
Ni	Dissolved Nickel	ug/L	200.7	70	70	70	<40	<40	D
Pb	Dissolved Lead	ug/L	200.7	<100	<100	D	<100	<100	D
Tl	Dissolved Thallium	ug/L	279.2	<100	<100	D	<100	<100	D
V	Dissolved Vanadium	ug/L	200.7	<20	<20	D	<20	<20	D
Zn	Dissolved Zinc	ug/L	200.7	220	110	165	<20	<20	D
Plot Size	Plot Size	Hectares		0.0016	0.0016	0.0016	0.0016	0.0016	0.0016
Rainfall Depth	Depth of Rainfall	mm		31.67	31.67	31.67	31.67	31.67	31.67
Rainfall Duration	Duration of Storm Event	min		100	100	100	100	100	100
Runoff Volume	Volume of Water Collected	L		394.25	439.23	416.74	420.31	451.39	435.85
Sediment Capture	Weight of Sediment Collected	kg		0.1	0.16	0.13	9.64	29.68	19.66
Total Rate of Sediment Capture	(TSS + Sediment Capture)/Runoff Volume	kg/L		0.00041	0.00047	0.00044	0.02335	0.07027	0.04681
Runoff Rate	Runoff Volume / Plot Size	L/Hectare		243551.97	271338.83	257445.40	259650.80	278850.79	269250.80
Erosion Rate	Weight of Sediment collected / Plot Size	kg/Hectare		61.78	98.84	80.31	5955.21	18335.12	12145.17
Total Erosion Rate	Total Rate of Sediment Capture X Runoff Rate	kg/Hectare		0.03	0.05	0.04	139.03	1288.42	713.72

S.E.R.L = San Diego State University Soil Erosion Research Laboratory
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C = Storm Event did not produce sufficient runoff to enable sampling using automated samplers.
D = Below Limit of Detection
N/A = Not Applicable

3.785L = 1gal
1hectare = 2.47104acres
0.454kg = 1lb

Test Material: Soil Sement

Application Rate: 6266.43 L/hectare

TPSSES Storm Event

Parameter	Description	Units	EPA Test Number	55S/12-203 February 12,2001 coarse	55S/12-203 February 24-26,2001 coarse	55S/12-203 March 6,2001 coarse	55S/12-203 April 7,2001 coarse
				Site/Plot Date Soil Type			
pH		pH units	150.1	10.4	8.8	C	9.4
EC	Specifc Conductivity	umhos/cm	120.1	645	275	C	192
TSS	Total Susspended Solids	mg/L	160.2	70	201	C	316
TDS	Total Dissolved Solids	mg/L	160.1	418	272	C	86
Hardness	as $CaCO_3$	mg/L	130.2	78	250	C	13
BOD	Biological Oxygen Demand	mg/L	405.1	A	A	C	A
COD	Chemical Oxygen Demand	mg/L	410.4	A	A	C	A
DOC	Dissolved Organic Carbon	mg/L	415.1	48	25	C	17
TOC	Total Organic Carbon	mg/L	415.1	41	28	C	24
NO_3	as Nitrogen	mg/L	300.0	2.9	0.4	C	0.3
TKN	Total Kjedahl Nitrogen	mg/L	351.3	2.4	0.8	C	1.7
P	Phosphorous	mg/L	365.2	0.13	0.34	C	0.16
Ortho-P	Dissolved Ortho-Phosphate	mg/L	365.2	< 0.03	0.07	C	0.09
NH_3-N	Ammonia	mg/L	350.2	0.3	0.11	C	A
$S0_4$	Sulfate	mg/L	300.0	118	18	C	14
TPH	Heavy Oil	mg/L	8015DRO	< 50	< 50	C	A
NO_2	Nitrite	mg/L	A	A	A	C	A
Al	Aluminum	ug/L	A	A	A	C	A
As	Arsenic	ug/L	200.8	8.1	11	C	8.6
Ba	Barium	ug/L	A	A	A	C	A
Ca	Calcium	ug/L	200.8	31400	17900	C	5090
Cd	Cadmium	ug/L	200.8	< 0.2	< 0.2	C	0.6
Cr	Chromium	ug/L	200.8	16	13	C	12
Cu	Copper	ug/L	200.8	11	13	C	39
Fe	Iron	ug/L	200.7	2180	7430	C	8110
Hg	Mercury	ng/L	**1631	900	2200	C	< 50
K	Potassium	ug/L	200.7	33200	15800	C	42900
Li	Lithium	ug/L	A	A	A	C	A
Mg	Magnesium	ug/L	200.7	2270	3320	C	3560
Na	Sodium	ug/L	200.7	66100	52300	C	1710
Ni	Nickel	ug/L	200.8	3.6	5.7	C	7
Pb	Lead	ug/L	200.8	1.8	4.7	C	21
Tl	Thallium	ug/L	A	A	A	C	A
V	Vanadium	ug/L	A	A	A	C	A
Zn	Zinc	ug/L	200.8	12	29	C	600
Al	Dissolved Aluminum	ug/L	A	A	A	C	A
As	Dissolved Arsenic	ug/L	200.8	7.1	9.1	C	7.3
Ba	Dissolved Barium	ug/L	A	A	A	C	A
Ca	Dissolved Calcium	ug/L	200.7	26500	12100	C	5090
Cd	Dissolved Cadmium	ug/L	200.8	<0.2	<0.2	C	<0.2
Cr	Dissolved Chromium	ug/L	200.8	14	8	C	3.8
Cu	Dissolved Copper	ug/L	200.8	5.3	8.4	C	3.8
Fe	Dissolved Iron	ug/L	200.7	300	1790	C	<25
Hg	Dissolved Mercury	ng/L	**1631	730	1700	C	<50
K	Dissolved Potassium	ug/L	200.7	30700	13800	C	42100
Li	Dissolved Lithium	ug/L	A	A	A	C	A
Mg	Dissolved Magnesium	ug/L	200.7	1590	1410	C	<100
Na	Dissolved Sodium	ug/L	200.7	45400	50900	C	15800
Ni	Dissolved Nickel	ug/L	200.8	2	2.3	C	<2
Pb	Dissolved Lead	ug/L	200.8	<1	1.5	C	<1
Tl	Dissolved Thallium	ug/L	A	A	A	C	A
V	Dissolved Vanadium	ug/L	A	A	A	C	A
Zn	Dissolved Zinc	ug/L	200.8	10	8.4	C	<5
Plot Size	Plot Size	Hectares		0.247104	0.247104	C	0.247104
Rainfall Depth	Depth of Rainfall	mm		34.54	47.24	C	7.37
Rainfall Duration	Duration of Storm Event	min		720	2880	C	600
Runoff Volume	Volume of Water Collected	L		D	D	C	254.87
Sediment Capture	Weight of Sediment Collected	kg		A	A	C	A
Total Rate of Sediment Capture	(TSS + Sediment Capture)/Runoff Volume	kg/L		A	A	C	A
Runoff Rate	Runoff Volume / Plot Size	L/Hectare		A	A	C	1031.428063
Erosion Rate	Weight of Sediment collected / Plot Size	kg/Hectare		A	A	C	A
Total Erosion Rate	Total Rate of Sediment Capture X Runoff Rate	kg/Hectare		A	A	C	A

S.E.R.L = San Diego State University Soil Erosion Research Laboratory
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N/A = Not Applicable

3.785L = 1gal
1hectare = 2.47104acres
0.454kg = 1lb

Test Material: Soil Sement

Application Rate: 6266.43 L/hectare

San Diego State University Soil Erosion Reasearch Laboratory Storm Event

Parameter	Description	Units	EPA Test Number	SERL/ 10 Year 1 August 16, 2001 coarse	SERL/10 Year 2 August 17, 2001 coarse	SERL/ 10 Year 1&2 MEAN coarse	SERL/ 10 Year 1 July 14, 2001 fine	SERL/10 Year 2 July 15, 2001 fine	SERL/10 Year 1&2 MEAN fine
				Site/Design Storm Date Soil Type					
pH		pH units	150.1	8.13	8.64	8.385	7.78	8.33	8.06
EC	Specifc Conductivity	umhos/cm	A	A	A	A	A	A	A
TSS	Total Susspended Solids	mg/L	160.2	2500	7936.00	5218	13073.83	17375.00	15224.42
TDS	Total Dissolved Solids	mg/L	A	A	A	A	A	A	A
Hardness	as $CaCO_3$	mg/L	A	A	A	A	A	A	A
BOD	Biological Oxygen Demand	mg/L	405.1	9	4.00	6.5	32.33	5.83	19.08
COD	Chemical Oxygen Demand	mg/L	A	39	21.00	30	146.83	52.20	99.52
DOC	Dissolved Organic Carbon	mg/L	A	A	A	A	A	A	A
TOC	Total Organic Carbon	mg/L	415.2	13.4	5.40	9.4	40.97	6.73	23.85
NO_3	as Nitrogen	mg/L	353.3	0.97	0.55	0.76	0.22	0.34	0.28
TKN	Total Kjedahl Nitrogen	mg/L	351.4	6.96	7.43	7.195	4.45	1.41	2.93
P	Phosphorous	mg/L	365.2	0.06	0.41	0.235	0.13	0.11	0.12
Ortho-P	Dissolved Ortho-Phosphate	mg/L	A	A	A	A	A	A	A
NH_3-N	Ammonia	mg/L	A	A	A	A	A	A	A
$S0_4$	Sulfate	mg/L	A	A	A	A	A	A	A
TPH	Heavy Oil	mg/L	A	A	A	A	A	A	A
NO_2	Nitrite	mg/L	354.1	0.27	0.11	0.19	0.69	0.11	0.40
Al	Aluminum	ug/L	200.7	A	A	A	A	A	A
As	Arsenic	ug/L	206.2	A	A	A	A	A	A
Ba	Barium	ug/L	200.7	A	A	A	A	A	A
Ca	Calcium	ug/L	200.7	A	A	A	A	A	A
Cd	Cadmium	ug/L	200.7	A	A	A	A	A	A
Cr	Chromium	ug/L	200.7	A	A	A	A	A	A
Cu	Copper	ug/L	200.7	A	A	A	A	A	A
Fe	Iron	ug/L	200.7	A	A	A	A	A	A
Hg	Mercury	ng/L	245.1	A	A	A	A	A	A
K	Potassium	ug/L	A	A	A	A	A	A	A
Li	Lithium	ug/L	200.7	A	A	A	A	A	A
Mg	Magnesium	ug/L	200.7	A	A	A	A	A	A
Na	Sodium	ug/L	A	A	A	A	A	A	A
Ni	Nickel	ug/L	200.7	A	A	A	A	A	A
Pb	Lead	ug/L	200.7	A	A	A	A	A	A
Tl	Thallium	ug/L	279.2	A	A	A	A	A	A
V	Vanadium	ug/L	200.7	A	A	A	A	A	A
Zn	Zinc	ug/L	200.7	A	A	A	A	A	A
Al	Dissolved Aluminum	ug/L	200.7	250	420	335	<100	30	D
As	Dissolved Arsenic	ug/L	206.2	<10	10	D	<10	<10	D
Ba	Dissolved Barium	ug/L	200.7	50	34	42	41.66666667	60	50.83
Ca	Dissolved Calcium	ug/L	200.7	36600	9400	23000	150583.3333	29316.66667	89950.00
Cd	Dissolved Cadmium	ug/L	200.7	<20	<20	D	40	<20	D
Cr	Dissolved Chromium	ug/L	200.7	<10	<10	D	30	30	30.00
Cu	Dissolved Copper	ug/L	200.7	<10	<10	D	10	10	10.00
Fe	Dissolved Iron	ug/L	200.7	30	30	30	90	83.33333333	86.67
Hg	Dissolved Mercury	ng/L	245.1	<2000	<2000	D	<2000	<2000	D
K	Dissolved Potassium	ug/L	A	A	A	A	A	A	A
Li	Dissolved Lithium	ug/L	200.7	<20	<20	D	<20	<20	D
Mg	Dissolved Magnesium	ug/L	200.7	6500	1700	4100	23416.66667	10075	16745.83
Na	Dissolved Sodium	ug/L	A	A	A	A	A	A	A
Ni	Dissolved Nickel	ug/L	200.7	<40	<40	D	<40	<40	D
Pb	Dissolved Lead	ug/L	200.7	<100	<100	D	<100	<100	D
Tl	Dissolved Thallium	ug/L	279.2	<100	<100	D	<100	<100	D
V	Dissolved Vanadium	ug/L	200.7	<20	<20	D	<20	<20	D
Zn	Dissolved Zinc	ug/L	200.7	<20	40	D	53.33333333	43.33333333	48.33
Plot Size	Plot Size	Hectares		0.0016	0.0016	0.0016	0.0016	0.0016	0.0016
Rainfall Depth	Depth of Rainfall	mm		31.67	31.67	31.67	31.67	31.67	31.67
Rainfall Duration	Duration of Storm Event	min		100	100	100	100	100	100
Runoff Volume	Volume of Water Collected	L		428.87	405.93	417.4	483.63	471.86	477.75
Sediment Capture	Weight of Sediment Collected	kg		30.51	26.53	28.52	24.63	33.99	29.31
Total Rate of Sediment Capture	(TSS + Sediment Capture)/Runoff Volume	kg/L		0.07364	0.07329	0.07347	0.06400	0.08941	0.07671
Runoff Rate	Runoff Volume / Plot Size	L/Hectare		264938.83	250767.41	257853.12	298767.38	291496.35	295131.86
Erosion Rate	Weight of Sediment collected / Plot Size	kg/Hectare		18847.86	16389.18	17618.52	15215.43	20997.67	18106.55
Total Erosion Rate	Total Rate of Sediment Capture X Runoff Rate	kg/Hectare		1387.97	1201.20	1294.58	973.81	1877.38	1425.59

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N/A = Not Applicable

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1hectare = 2.47104acres
0.454kg = 1lb

Test Material: Bare Soil

Application Rate: N/A

Parameter	Description	Units	EPA Test Number	TPSSES Storm Event — Site/Plot, Date, Soil Type: 73S/12-204, February 12,2001, fine	73S/12-204, February 24-26,2001, fine	73S/12-204, March 6,2001, fine	73S/12-204, April 7,2001, fine
pH		pH units	150.1	B	10.3	C	8.2
EC	Specifc Conductivity	umhos/cm	120.1	B	131	C	170
TSS	Total Susspended Solids	mg/L	160.2	B	149	C	9510
TDS	Total Dissolved Solids	mg/L	160.1	B	122	C	125
Hardness	as $CaCO_3$	mg/L	130.2	B	21	C	182
BOD	Biological Oxygen Demand	mg/L	405.1	B	22	C	< 3
COD	Chemical Oxygen Demand	mg/L	410.4	B	66	C	75
DOC	Dissolved Organic Carbon	mg/L	415.1	B	12	C	7.2
TOC	Total Organic Carbon	mg/L	415.1	B	15	C	7.8
NO_3	as Nitrogen	mg/L	300.0	B	< 0.1	C	< 0.1
TKN	Total Kjedahl Nitrogen	mg/L	351.3	B	0.3	C	7.5
P	Phosphorous	mg/L	365.2	B	0.28	C	12.3
Ortho-P	Dissolved Ortho-Phosphate	mg/L	365.2	B	< 0.03	C	0.07
NH_3-N	Ammonia	mg/L	350.2	B	2	C	A
SO_4	Sulfate	mg/L	300.0	B	< 1	C	60
TPH	Heavy Oil	mg/L	8015DRO	B	A	C	A
NO_2	Nitrite	mg/L	A	B	A	C	A
Al	Aluminum	ug/L	A	B	A	C	A
As	Arsenic	ug/L	200.8	B	< 1	C	11.8
Ba	Barium	ug/L	A	B	A	C	A
Ca	Calcium	ug/L	200.8	B	A	C	A
Cd	Cadmium	ug/L	200.8	B	< 0.2	C	8.2
Cr	Chromium	ug/L	200.8	B	7.7	C	217
Cu	Copper	ug/L	200.8	B	2.5	C	74
Fe	Iron	ug/L	200.7	B	A	C	A
Hg	Mercury	ng/L	**1631	B	A	C	A
K	Potassium	ug/L	200.7	B	A	C	A
Li	Lithium	ug/L	A	B	A	C	A
Mg	Magnesium	ug/L	200.7	B	A	C	A
Na	Sodium	ug/L	200.7	B	A	C	A
Ni	Nickel	ug/L	200.8	B	3.6	C	137
Pb	Lead	ug/L	200.8	B	1.1	C	46
Tl	Thallium	ug/L	A	B	A	C	A
V	Vanadium	ug/L	A	B	A	C	A
Zn	Zinc	ug/L	200.8	B	15	C	542
Al	Dissolved Aluminum	ug/L	A	B	A	C	A
As	Dissolved Arsenic	ug/L	200.8	B	<1	C	<1
Ba	Dissolved Barium	ug/L	A	B	A	C	A
Ca	Dissolved Calcium	ug/L	200.7	B	A	C	A
Cd	Dissolved Cadmium	ug/L	200.8	B	<0.2	C	<0.2
Cr	Dissolved Chromium	ug/L	200.8	B	2.3	C	<1
Cu	Dissolved Copper	ug/L	200.8	B	1.9	C	<1
Fe	Dissolved Iron	ug/L	200.7	B	A	C	A
Hg	Dissolved Mercury	ng/L	**1631	B	A	C	A
K	Dissolved Potassium	ug/L	200.7	B	A	C	A
Li	Dissolved Lithium	ug/L	A	B	A	C	A
Mg	Dissolved Magnesium	ug/L	200.7	B	A	C	A
Na	Dissolved Sodium	ug/L	200.7	B	A	C	A
Ni	Dissolved Nickel	ug/L	200.8	B	<2	C	<2
Pb	Dissolved Lead	ug/L	200.8	B	<1	C	<1
Tl	Dissolved Thallium	ug/L	A	B	A	C	A
V	Dissolved Vanadium	ug/L	A	B	A	C	A
Zn	Dissolved Zinc	ug/L	200.8	B	<5	C	<5
Plot Size	Plot Size	Hectares		B	0.494208	C	0.494208
Rainfall Depth	Depth of Rainfall	mm		B	64.48	C	18.8
Rainfall Duration	Duration of Storm Event	min		B	2880	C	600
Runoff Volume	Volume of Water Collected	L		B	6145.13	C	623.01
Sediment Capture	Weight of Sediment Collected	kg		B	A	C	A
Total Rate of Sediment Capture	(TSS + Sediment Capture)/Runoff Volume	kg/L		B	A	C	A
Runoff Rate	Runoff Volume / Plot Size	L/Hectare		B	12434.29892	C	1260.623057
Erosion Rate	Weight of Sediment collected / Plot Size	kg/Hectare		B	A	C	A
Total Erosion Rate	Total Rate of Sediment Capture X Runoff Rate	kg/Hectare		B	A	C	A

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D = Below Limit of Detection
N/A = Not Applicable

3.785L = 1gal
1hectare = 2.47104acres
0.454kg = 1lb

Test Material: Bare Soil

Application Rate: N/A

Parameter	Description	Units	EPA Test Number	San Diego State University Soil Erosion Reasearch Laboratory Storm Event — Site/Design Storm, Date, Soil Type: SERL/ 10 Year 1, August 14, 2001, coarse	SERL/10 Year 2, August 15, 2001, coarse	SERL/ 10 Year 1&2, MEAN, coarse	SERL/ 10 Year 1, July 11, 2001, fine	SERL/10 Year 2, July 12, 2001, fine	SERL/10 Year 1&2, MEAN, fine
pH		pH units	150.1	9.03	8.88	8.955	8.33	8.47	8.40
EC	Specifc Conductivity	umhos/cm	A	A	A	A	A	A	A
TSS	Total Susspended Solids	mg/L	160.2	4200	8306.00	6253	37592.83	17787.58	27690.21
TDS	Total Dissolved Solids	mg/L	A	A	A	A	A	A	A
Hardness	as $CaCO_3$	mg/L	A	A	A	A	A	A	A
BOD	Biological Oxygen Demand	mg/L	405.1	<2.0	127.00	D	4.00	2.67	3.33
COD	Chemical Oxygen Demand	mg/L	A	45	6.00	25.5	30.83	41.33	36.08
DOC	Dissolved Organic Carbon	mg/L	A	A	A	A	A	A	A
TOC	Total Organic Carbon	mg/L	415.2	7.1	2.60	4.85	4.85	3.39	4.12
NO_3	as Nitrogen	mg/L	353.3	0.32	0.42	0.37	0.64	0.27	0.45
TKN	Total Kjedahl Nitrogen	mg/L	351.4	5.98	3.04	4.51	11.32	5.81	8.57
P	Phosphorous	mg/L	365.2	0.49	0.44	0.465	0.18	0.18	0.18
Ortho-P	Dissolved Ortho-Phosphate	mg/L	A	A	A	A	A	A	A
NH_3-N	Ammonia	mg/L	A	A	A	A	A	A	A
SO_4	Sulfate	mg/L	A	A	A	A	A	A	A
TPH	Heavy Oil	mg/L	A	A	A	A	A	A	A
NO_2	Nitrite	mg/L	354.1	<0.05	<0.05	D	<0.05	<0.05	D
Al	Aluminum	ug/L	200.7	A	A	A	A	A	A
As	Arsenic	ug/L	206.2	A	A	A	A	A	A
Ba	Barium	ug/L	200.7	A	A	A	A	A	A
Ca	Calcium	ug/L	200.7	A	A	A	A	A	A
Cd	Cadmium	ug/L	200.7	A	A	A	A	A	A
Cr	Chromium	ug/L	200.7	A	A	A	A	A	A
Cu	Copper	ug/L	200.7	A	A	A	A	A	A
Fe	Iron	ug/L	200.7	A	A	A	A	A	A
Hg	Mercury	ng/L	245.1	A	A	A	A	A	A
K	Potassium	ug/L	A	A	A	A	A	A	A
Li	Lithium	ug/L	200.7	A	A	A	A	A	A
Mg	Magnesium	ug/L	200.7	A	A	A	A	A	A
Na	Sodium	ug/L	A	A	A	A	A	A	A
Ni	Nickel	ug/L	200.7	A	A	A	A	A	A
Pb	Lead	ug/L	200.7	A	A	A	A	A	A
Tl	Thallium	ug/L	279.2	A	A	A	A	A	A
V	Vanadium	ug/L	200.7	A	A	A	A	A	A
Zn	Zinc	ug/L	200.7	A	A	A	A	A	A
Al	Dissolved Aluminum	ug/L	200.7	350	300	325	<100	<100	D
As	Dissolved Arsenic	ug/L	206.2	<10	<10	D	<10	<10	D
Ba	Dissolved Barium	ug/L	200.7	420	10	215	26.66666667	20	23.33
Ca	Dissolved Calcium	ug/L	200.7	4800	4600	4700	66750	22625	44687.50
Cd	Dissolved Cadmium	ug/L	200.7	<20	<20	D	<20	<20	D
Cr	Dissolved Chromium	ug/L	200.7	<10	<10	D	20	<10	D
Cu	Dissolved Copper	ug/L	200.7	<10	<10	D	<10	<10	D
Fe	Dissolved Iron	ug/L	200.7	<50	90	D	<50	64.16666667	D
Hg	Dissolved Mercury	ng/L	245.1	<2000	<2000	D	<2000	<2000	D
K	Dissolved Potassium	ug/L	A	A	A	A	A	A	A
Li	Dissolved Lithium	ug/L	200.7	<20	<20	D	<20	<20	D
Mg	Dissolved Magnesium	ug/L	200.7	800	800	800	17123.33333	8165	12644.17
Na	Dissolved Sodium	ug/L	A	A	A	A	A	A	A
Ni	Dissolved Nickel	ug/L	200.7	<40	<40	D	<40	40	D
Pb	Dissolved Lead	ug/L	200.7	<100	<100	D	<100	<100	D
Tl	Dissolved Thallium	ug/L	279.2	<100	<100	D	<100	<100	D
V	Dissolved Vanadium	ug/L	200.7	<20	<20	D	<20	40	D
Zn	Dissolved Zinc	ug/L	200.7	200	30	115	<20	30	D
Plot Size	Plot Size	Hectares		0.0016	0.0016	0.0016	0.0016	0.0016	0.0016
Rainfall Depth	Depth of Rainfall	mm		31.67	31.67	31.67	31.67	31.67	31.67
Rainfall Duration	Duration of Storm Event	min		100	100	100	100	100	100
Runoff Volume	Volume of Water Collected	L		358.32	425.34	391.83	390.65	469.81	430.23
Sediment Capture	Weight of Sediment Collected	kg		33.91	19.05	26.48	45.94	48.46	47.2
Total Rate of Sediment Capture	(TSS + Sediment Capture)/Runoff Volume	kg/L		0.09884	0.05309	0.07596	0.15519	0.12094	0.13806
Runoff Rate	Runoff Volume / Plot Size	L/Hectare		221355.85	262758.14	242056.99	241328.04	290229.94	265778.99
Erosion Rate	Weight of Sediment collected / Plot Size	kg/Hectare		20948.25	11768.33	16358.29	28379.91	29936.66	29158.28
Total Erosion Rate	Total Rate of Sediment Capture X Runoff Rate	kg/Hectare		2070.44	624.82	1347.63	4404.33	3620.41	4012.37

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D = Below Limit of Detection
N/A = Not Applicable

3.785L = 1gal
1hectare = 2.47104acres
0.454kg = 1lb

Test Material: Tacking Agent III

Application Rate: 89.7482 kg/hectare

Parameter	Description	Units	EPA Test Number	TPSSES Storm Event — Site/Plot, Date, Soil Type: 73S/12-205 February 12,2001 fine	73S/12-205 February 24-26,2001 fine	73S/12-205 March 6,2001 fine	73S/12-205 April 7,2001 fine
pH		pH units	150.1	B	9	C	8
EC	Specifc Conductivity	umhos/cm	120.1	B	52	C	120
TSS	Total Susspended Solids	mg/L	160.2	B	13301	C	4392
TDS	Total Dissolved Solids	mg/L	160.1	B	72	C	99
Hardness	as $CaCO_3$	mg/L	130.2	B	78	C	102
BOD	Biological Oxygen Demand	mg/L	405.1	B	3	C	< 3
COD	Chemical Oxygen Demand	mg/L	410.4	B	66	C	28
DOC	Dissolved Organic Carbon	mg/L	415.1	B	8.4	C	5
TOC	Total Organic Carbon	mg/L	415.1	B	7.7	C	11
NO_3	as Nitrogen	mg/L	300.0	B	< 0.1	C	0.2
TKN	Total Kjedahl Nitrogen	mg/L	351.3	B	4.1	C	5.6
P	Phosphorous	mg/L	365.2	B	0.26	C	0.24
Ortho-P	Dissolved Ortho-Phosphate	mg/L	365.2	B	< 0.3	C	0.13
NH_3-N	Ammonia	mg/L	350.2	B	< 0.1	C	A
$S0_4$	Sulfate	mg/L	300.0	B	9	C	34
TPH	Heavy Oil	mg/L	8015DRO	B	A	C	A
NO_2	Nitrite	mg/L	A	B	A	C	A
Al	Aluminum	ug/L	A	B	A	C	A
As	Arsenic	ug/L	200.8	B	8.5	C	8.4
Ba	Barium	ug/L	A	B	A	C	A
Ca	Calcium	ug/L	200.8	B	A	C	A
Cd	Cadmium	ug/L	200.8	B	6	C	4
Cr	Chromium	ug/L	200.8	B	109	C	102
Cu	Copper	ug/L	200.8	B	39	C	37
Fe	Iron	ug/L	200.7	B	A	C	A
Hg	Mercury	ng/L	**1631	B	A	C	A
K	Potassium	ug/L	200.7	B	A	C	A
Li	Lithium	ug/L	A	B	A	C	A
Mg	Magnesium	ug/L	200.7	B	A	C	A
Na	Sodium	ug/L	200.7	B	A	C	A
Ni	Nickel	ug/L	200.8	B	71	C	65
Pb	Lead	ug/L	200.8	B	27	C	22
Tl	Thallium	ug/L	A	B	A	C	A
V	Vanadium	ug/L	A	B	A	C	A
Zn	Zinc	ug/L	200.8	B	262	C	250
Al	Dissolved Aluminum	ug/L	A	B	A	C	A
As	Dissolved Arsenic	ug/L	200.8	B	4.4	C	<1
Ba	Dissolved Barium	ug/L	A	B	A	C	A
Ca	Dissolved Calcium	ug/L	200.7	B	A	C	A
Cd	Dissolved Cadmium	ug/L	200.8	B	<0.2	C	<0.2
Cr	Dissolved Chromium	ug/L	200.8	B	1.3	C	<1
Cu	Dissolved Copper	ug/L	200.8	B	1.5	C	1
Fe	Dissolved Iron	ug/L	200.8	B	A	C	A
Hg	Dissolved Mercury	ng/L	200.8	B	A	C	A
K	Dissolved Potassium	ug/L	200.8	B	A	C	A
Li	Dissolved Lithium	ug/L	200.8	B	A	C	A
Mg	Dissolved Magnesium	ug/L	200.8	B	A	C	A
Na	Dissolved Sodium	ug/L	200.8	B	A	C	A
Ni	Dissolved Nickel	ug/L	200.8	B	<2	C	3
Pb	Dissolved Lead	ug/L	200.8	B	<1	C	<1
Tl	Dissolved Thallium	ug/L	200.8	B	A	C	A
V	Dissolved Vanadium	ug/L	200.8	B	A	C	A
Zn	Dissolved Zinc	ug/L	200.8	B	<5	C	<5
Plot Size	Plot Size	Hectares		B	0.494208	C	0.494208
Rainfall Depth	Depth of Rainfall	mm		B	61.47	C	16
Rainfall Duration	Duration of Storm Event	min		B	2880	C	600
Runoff Volume	Volume of Water Collected	L		B	6003.54	C	3653.1
Sediment Capture	Weight of Sediment Collected	kg		B	A	C	A
Total Rate of Sediment Capture	(TSS + Sediment Capture)/Runoff Volume	kg/L		B	A	C	A
Runoff Rate	Runoff Volume / Plot Size	L/Hectare		B	12147.80012	C	7391.826923
Erosion Rate	Weight of Sediment collected / Plot Size	kg/Hectare		B	A	C	A
Total Erosion Rate	Total Rate of Sediment Capture X Runoff Rate	kg/Hectare		B	A	C	A

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N/A = Not Applicable

3.785L = 1gal
1hectare = 2.47104acres
0.454kg = 1lb

Test Material: Tacking Agent III

Application Rate: 89.7482 kg/hectare

Parameter	Description	Units	EPA Test Number	San Diego State University Soil Erosion Reasearch Laboratory Storm Event — Site/Design Storm, Date, Soil Type: SERL/ 10 Year 1 August 21, 2001 coarse	SERL/10 Year 2 August 22, 2001 coarse	SERL/ 10 Year 1&2 MEAN coarse	SERL/ 10 Year 1 July 17, 2001 fine	SERL/10 Year 2 July 18, 2001 fine	SERL/10 Year 1&2 MEAN fine
pH		pH units	150.1	8.5	8.87	8.685	8.24	8.45	8.35
EC	Specifc Conductivity	umhos/cm	A	A	A	A	A	A	A
TSS	Total Susspended Solids	mg/L	160.2	40818	20472.00	30645	47804.00	14958.00	31381.00
TDS	Total Dissolved Solids	mg/L	A	A	A	A	A	A	A
Hardness	as $CaCO_3$	mg/L	A	A	A	A	A	A	A
BOD	Biological Oxygen Demand	mg/L	405.1	3	<2.0	D	5.83	2.20	4.02
COD	Chemical Oxygen Demand	mg/L	A	12	24.00	18	52.33	39.00	45.67
DOC	Dissolved Organic Carbon	mg/L	A	A	A	A	A	A	A
TOC	Total Organic Carbon	mg/L	415.2	8.5	6.20	7.35	8.43	3.78	6.11
NO_3	as Nitrogen	mg/L	353.3	1.26	0.52	0.89	0.68	0.34	0.51
TKN	Total Kjedahl Nitrogen	mg/L	351.4	13.2	12.40	12.8	2.03	6.00	4.02
P	Phosphorous	mg/L	365.2	0.09	0.14	0.115	0.08	0.10	0.09
Ortho-P	Dissolved Ortho-Phosphate	mg/L	A	A	A	A	A	A	A
NH_3-N	Ammonia	mg/L	A	A	A	A	A	A	A
$S0_4$	Sulfate	mg/L	A	A	A	A	A	A	A
TPH	Heavy Oil	mg/L	A	A	A	A	A	A	A
NO_2	Nitrite	mg/L	354.1	0.14	<0.05	D	0.16	<0.05	D
Al	Aluminum	ug/L	200.7	A	A	A	A	A	A
As	Arsenic	ug/L	206.2	A	A	A	A	A	A
Ba	Barium	ug/L	200.7	A	A	A	A	A	A
Ca	Calcium	ug/L	200.7	A	A	A	A	A	A
Cd	Cadmium	ug/L	200.7	A	A	A	A	A	A
Cr	Chromium	ug/L	200.7	A	A	A	A	A	A
Cu	Copper	ug/L	200.7	A	A	A	A	A	A
Fe	Iron	ug/L	200.7	A	A	A	A	A	A
Hg	Mercury	ng/L	245.1	A	A	A	A	A	A
K	Potassium	ug/L	A	A	A	A	A	A	A
Li	Lithium	ug/L	200.7	A	A	A	A	A	A
Mg	Magnesium	ug/L	200.7	A	A	A	A	A	A
Na	Sodium	ug/L	A	A	A	A	A	A	A
Ni	Nickel	ug/L	200.7	A	A	A	A	A	A
Pb	Lead	ug/L	200.7	A	A	A	A	A	A
Tl	Thallium	ug/L	279.2	A	A	A	A	A	A
V	Vanadium	ug/L	200.7	A	A	A	A	A	A
Zn	Zinc	ug/L	200.7	A	A	A	A	A	A
Al	Dissolved Aluminum	ug/L	200.7	140	320	230	30	<100	D
As	Dissolved Arsenic	ug/L	206.2	10	17	13.5	<10	<10	D
Ba	Dissolved Barium	ug/L	200.7	50	30	40	80	26.66666667	53.33
Ca	Dissolved Calcium	ug/L	200.7	35600	10200	22900	140500	23066.66667	81783.33
Cd	Dissolved Cadmium	ug/L	200.7	<20	<20	D	<20	<20	D
Cr	Dissolved Chromium	ug/L	200.7	<10	<10	D	30	20	25.00
Cu	Dissolved Copper	ug/L	200.7	<10	<10	D	10	10	10.00
Fe	Dissolved Iron	ug/L	200.7	<50	<50	D	95	75	85.00
Hg	Dissolved Mercury	ng/L	245.1	<2000	<2000	D	<2000	<2000	D
K	Dissolved Potassium	ug/L	A	A	A	A	A	A	A
Li	Dissolved Lithium	ug/L	200.7	<20	<20	D	<20	<20	D
Mg	Dissolved Magnesium	ug/L	200.7	7100	2000	4550	62483.33333	8370	35426.67
Na	Dissolved Sodium	ug/L	A	A	A	A	A	A	A
Ni	Dissolved Nickel	ug/L	200.7	<40	<40	D	<40	<40	D
Pb	Dissolved Lead	ug/L	200.7	<100	<100	D	<100	<100	D
Tl	Dissolved Thallium	ug/L	279.2	<100	<100	D	<100	<100	D
V	Dissolved Vanadium	ug/L	200.7	<20	<20	D	<20	<20	D
Zn	Dissolved Zinc	ug/L	200.7	<20	<20	D	40	33.33333333	36.67
Plot Size	Plot Size	Hectares		0.0016	0.0016	0.0016	0.0016	0.0016	0.0016
Rainfall Depth	Depth of Rainfall	mm		31.67	31.67	31.67	31.67	31.67	31.67
Rainfall Duration	Duration of Storm Event	min		100	100	100	100	100	100
Runoff Volume	Volume of Water Collected	L		398.43	424.91	411.67	488.63	513.77	501.20
Sediment Capture	Weight of Sediment Collected	kg		33.47	20.44	26.955	86.09	49.29	67.69
Total Rate of Sediment Capture	(TSS + Sediment Capture)/Runoff Volume	kg/L		0.12482	0.06858	0.09670	0.22399	0.11090	0.16744
Runoff Rate	Runoff Volume / Plot Size	L/Hectare		246134.21	262492.50	254313.36	301856.18	317386.68	309621.43
Erosion Rate	Weight of Sediment collected / Plot Size	kg/Hectare		20676.44	12627.02	16651.73	53182.98	30449.40	41816.19
Total Erosion Rate	Total Rate of Sediment Capture X Runoff Rate	kg/Hectare		2580.89	865.91	1723.40	11912.48	3376.71	7644.60

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N/A = Not Applicable

3.785L = 1gal
1hectare = 2.47104acres
0.454kg = 1lb

Test Material: Airtrol

Application Rate: 5609.26 kg/hectare

TPSSES Storm Event

Parameter	Description	Units	EPA Test Number	Site/Plot Date Soil Type 73S/12-206 February 12,2001 fine	73S/12-206 February 24-26,2001 fine	73S/12-206 March 6,2001 fine	73S/12-206 April 7,2001 fine
pH		pH units	150.1	B	9.4	C	9.2
EC	Specifc Conductivity	umhos/cm	120.1	B	288	C	191
TSS	Total Susspended Solids	mg/L	160.2	B	188	C	37
TDS	Total Dissolved Solids	mg/L	160.1	B	264	C	128
Hardness	as $CaCO_3$	mg/L	130.2	B	43	C	49
BOD	Biological Oxygen Demand	mg/L	405.1	B	5	C	< 3
COD	Chemical Oxygen Demand	mg/L	410.4	B	60	C	27
DOC	Dissolved Organic Carbon	mg/L	415.1	B	6.2	C	13
TOC	Total Organic Carbon	mg/L	415.1	B	9	C	15
NO_3	as Nitrogen	mg/L	300.0	B	0.2	C	0.1
TKN	Total Kjedahl Nitrogen	mg/L	351.3	B	0.5	C	0.8
P	Phosphorous	mg/L	365.2	B	0.06	C	0.14
Ortho-P	Dissolved Ortho-Phosphate	mg/L	365.2	B	< 0.03	C	< 0.3
NH_3-N	Ammonia	mg/L	350.2	B	< 0.1	C	A
SO_4	Sulfate	mg/L	300.0	B	182	C	46
TPH	Heavy Oil	mg/L	8015DRO	B	A	C	A
NO_2	Nitrite	mg/L	A	B	A	C	A
Al	Aluminum	ug/L	A	B	A	C	A
As	Arsenic	ug/L	200.8	B	< 1	C	1
Ba	Barium	ug/L	A	B	A	C	A
Ca	Calcium	ug/L	200.8	B	A	C	A
Cd	Cadmium	ug/L	200.8	B	< 0.2	C	< 0.2
Cr	Chromium	ug/L	200.8	B	3.9	C	3.5
Cu	Copper	ug/L	200.8	B	1.4	C	1.9
Fe	Iron	ug/L	200.7	B	A	C	A
Hg	Mercury	ng/L	**1631	B	A	C	A
K	Potassium	ug/L	200.7	B	A	C	A
Li	Lithium	ug/L	A	B	A	C	A
Mg	Magnesium	ug/L	200.7	B	A	C	A
Na	Sodium	ug/L	200.7	B	A	C	A
Ni	Nickel	ug/L	200.8	B	< 2	C	< 2
Pb	Lead	ug/L	200.8	B	< 1	C	< 1
Tl	Thallium	ug/L	A	B	A	C	A
V	Vanadium	ug/L	A	B	A	C	A
Zn	Zinc	ug/L	200.8	B	5	C	7.8
Al	Dissolved Aluminum	ug/L	A	B	A	C	A
As	Dissolved Arsenic	ug/L	200.8	B	<1	C	<1
Ba	Dissolved Barium	ug/L	A	B	A	C	A
Ca	Dissolved Calcium	ug/L	200.7	B	A	C	A
Cd	Dissolved Cadmium	ug/L	200.8	B	<0.2	C	<0.2
Cr	Dissolved Chromium	ug/L	200.8	B	2.7	C	1.3
Cu	Dissolved Copper	ug/L	200.8	B	1	C	<1
Fe	Dissolved Iron	ug/L	200.7	B	A	C	A
Hg	Dissolved Mercury	ng/L	**1631	B	A	C	A
K	Dissolved Potassium	ug/L	200.7	B	A	C	A
Li	Dissolved Lithium	ug/L	A	B	A	C	A
Mg	Dissolved Magnesium	ug/L	200.7	B	A	C	A
Na	Dissolved Sodium	ug/L	200.7	B	A	C	A
Ni	Dissolved Nickel	ug/L	200.8	B	<2	C	<2
Pb	Dissolved Lead	ug/L	200.8	B	<1	C	<1
Tl	Dissolved Thallium	ug/L	A	B	A	C	A
V	Dissolved Vanadium	ug/L	A	B	A	C	A
Zn	Dissolved Zinc	ug/L	200.8	B	<5	C	<5
Plot Size	Plot Size	Hectares		B	0.494208	C	0.494208
Rainfall Depth	Depth of Rainfall	mm		B	61.47	C	16.26
Rainfall Duration	Duration of Storm Event	min		B	2880	C	600
Runoff Volume	Volume of Water Collected	L		B	2690.27	C	623.01
Sediment Capture	Weight of Sediment Collected	kg		B	A	C	A
Total Rate of Sediment Capture	(TSS + Sediment Capture)/Runoff Volume	kg/L		B	A	C	A
Runoff Rate	Runoff Volume / Plot Size	L/Hectare		B	5443.598647	C	1260.623057
Erosion Rate	Weight of Sediment collected / Plot Size	kg/Hectare		B	A	C	A
Total Erosion Rate	Total Rate of Sediment Capture X Runoff Rate	kg/Hectare		B	A	C	A

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3.785L = 1gal
1hectare = 2.47104acres
0.454kg = 1lb

Test Material: Airtrol

Application Rate: 5609.26 kg/hectare

San Diego State University Soil Erosion Reasearch Laboratory Storm Event

Parameter	Description	Units	EPA Test Number	Site/Design Storm Date Soil Type SERL/ 10 Year 1 Sept. 12, 2001 coarse	SERL/10 Year 2 Sept. 13, 2001 coarse	SERL/ 10 Year 1&2 MEAN coarse	SERL/ 10 Year 1 July 24, 2001 fine	SERL/10 Year 2 July 25, 2001 fine	SERL/10 Year 1&2 MEAN fine
pH		pH units	150.1	7.48	7.67	7.575	7.67	7.66	7.66
EC	Specifc Conductivity	umhos/cm	A	A	A	A	A	A	A
TSS	Total Susspended Solids	mg/L	160.2	8086	6238.00	7162	2858.42	2831.00	2844.71
TDS	Total Dissolved Solids	mg/L	A	A	A	A	A	A	A
Hardness	as $CaCO_3$	mg/L	A	A	A	A	A	A	A
BOD	Biological Oxygen Demand	mg/L	405.1	10	6.00	8	43.38	6.00	24.69
COD	Chemical Oxygen Demand	mg/L	A	49	24.00	36.5	161.00	41.50	101.25
DOC	Dissolved Organic Carbon	mg/L	A	A	A	A	A	A	A
TOC	Total Organic Carbon	mg/L	415.2	6.3	11.50	8.9	15.80	6.80	11.30
NO_3	as Nitrogen	mg/L	353.3	0.38	0.24	0.31	0.31	0.46	0.39
TKN	Total Kjedahl Nitrogen	mg/L	351.4	2.82	2.90	2.86	11.00	1.60	6.30
P	Phosphorous	mg/L	365.2	0.07	0.09	0.08	0.08	0.06	0.07
Ortho-P	Dissolved Ortho-Phosphate	mg/L	A	A	A	A	A	A	A
NH_3-N	Ammonia	mg/L	A	A	A	A	A	A	A
SO_4	Sulfate	mg/L	A	A	A	A	A	A	A
TPH	Heavy Oil	mg/L	A	A	A	A	A	A	A
NO_2	Nitrite	mg/L	354.1	<0.05	<0.05	D	0.08	<0.05	D
Al	Aluminum	ug/L	200.7	A	A	A	A	A	A
As	Arsenic	ug/L	206.2	A	A	A	A	A	A
Ba	Barium	ug/L	200.7	A	A	A	A	A	A
Ca	Calcium	ug/L	200.7	A	A	A	A	A	A
Cd	Cadmium	ug/L	200.7	A	A	A	A	A	A
Cr	Chromium	ug/L	200.7	A	A	A	A	A	A
Cu	Copper	ug/L	200.7	A	A	A	A	A	A
Fe	Iron	ug/L	200.7	A	A	A	A	A	A
Hg	Mercury	ng/L	245.1	A	A	A	A	A	A
K	Potassium	ug/L	A	A	A	A	A	A	A
Li	Lithium	ug/L	200.7	A	A	A	A	A	A
Mg	Magnesium	ug/L	200.7	A	A	A	A	A	A
Na	Sodium	ug/L	A	A	A	A	A	A	A
Ni	Nickel	ug/L	200.7	A	A	A	A	A	A
Pb	Lead	ug/L	200.7	A	A	A	A	A	A
Tl	Thallium	ug/L	279.2	A	A	A	A	A	A
V	Vanadium	ug/L	200.7	A	A	A	A	A	A
Zn	Zinc	ug/L	200.7	A	A	A	A	A	A
Al	Dissolved Aluminum	ug/L	200.7	300	380	340	420.8333333	570	495.42
As	Dissolved Arsenic	ug/L	206.2	<10	<10	D	<10	<10	D
Ba	Dissolved Barium	ug/L	200.7	60	50	55	40.83333333	40	40.42
Ca	Dissolved Calcium	ug/L	200.7	624000	555000	589500	675250	619000	647125.00
Cd	Dissolved Cadmium	ug/L	200.7	<20	<20	D	29	<20	D
Cr	Dissolved Chromium	ug/L	200.7	<10	<10	D	20	<10	D
Cu	Dissolved Copper	ug/L	200.7	<10	<10	D	<10	<10	D
Fe	Dissolved Iron	ug/L	200.7	<50	<50	D	464	50	257.00
Hg	Dissolved Mercury	ng/L	245.1	<2000	<2000	D	2000	<2000	D
K	Dissolved Potassium	ug/L	A	A	A	A	A	A	A
Li	Dissolved Lithium	ug/L	200.7	<20	<20	D	40	<20	D
Mg	Dissolved Magnesium	ug/L	200.7	30000	24500	27250	56791.66667	72300	64545.83
Na	Dissolved Sodium	ug/L	A	A	A	A	A	A	A
Ni	Dissolved Nickel	ug/L	200.7	<40	<40	D	<40	<40	D
Pb	Dissolved Lead	ug/L	200.7	<100	<100	D	<100	<100	D
Tl	Dissolved Thallium	ug/L	279.2	<100	<100	D	<100	<100	D
V	Dissolved Vanadium	ug/L	200.7	<20	<20	D	20	<20	D
Zn	Dissolved Zinc	ug/L	200.7	<20	<20	D	198.75	40	119.38
Plot Size	Plot Size	Hectares		0.0016	0.0016	0.0016	0.0016	0.0016	0.0016
Rainfall Depth	Depth of Rainfall	mm		31.67	31.67	31.67	31.67	31.67	31.67
Rainfall Duration	Duration of Storm Event	min		100	100	100	100	100	100
Runoff Volume	Volume of Water Collected	L		500.05	446.8	473.425	382.09	456.47	419.28
Sediment Capture	Weight of Sediment Collected	kg		4.02	2.37	3.195	0.67	0.66	0.665
Total Rate of Sediment Capture	(TSS + Sediment Capture)/Runoff Volume	kg/L		0.01613	0.01154	0.01383	0.00461	0.00428	0.00444
Runoff Rate	Runoff Volume / Plot Size	L/Hectare		308911.01	276015.27	292463.14	236040.01	281989.01	259014.51
Erosion Rate	Weight of Sediment collected / Plot Size	kg/Hectare		2483.40	1464.09	1973.74	413.90	407.72	410.81
Total Erosion Rate	Total Rate of Sediment Capture X Runoff Rate	kg/Hectare		40.05	16.90	28.47	1.91	1.74	1.83

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N/A = Not Applicable

3.785L = 1gal
1hectare = 2.47104acres
0.454kg = 1lb

Test Material: Ultra Tack

Application Rate: 28.0463 kg/hectare

TPSSES Storm Event				Site/Plot Date Soil Type			
Parameter	Description	Units	EPA Test Number	73S/12-207 February 12,2001 fine	73S/12-207 February 24-26,2001 fine	73S/12-207 March 6,2001 fine	73S/12-207 April 7,2001 fine
pH		pH units	150.1	B	9.8	7.3	8.9
EC	Specifc Conductivity	umhos/cm	120.1	B	117	207	292
TSS	Total Susspended Solids	mg/L	160.2	B	150	300	54
TDS	Total Dissolved Solids	mg/L	160.1	B	128	196	262
Hardness	as $CaCO_3$	mg/L	130.2	B	37	100	110
BOD	Biological Oxygen Demand	mg/L	405.1	B	49	15	< 3
COD	Chemical Oxygen Demand	mg/L	410.4	B	97	174	105
DOC	Dissolved Organic Carbon	mg/L	415.1	B	17	21	36
TOC	Total Organic Carbon	mg/L	415.1	B	17	22	37
NO_3	as Nitrogen	mg/L	300.0	B	< 0.1	0.1	2.2
TKN	Total Kjedahl Nitrogen	mg/L	351.3	B	0.6	0.5	1.5
P	Phosphorous	mg/L	365.2	B	0.19	0.31	0.05
Ortho-P	Dissolved Ortho-Phosphate	mg/L	365.2	B	< 0.03	< 0.03	0.38
NH_3-N	Ammonia	mg/L	350.2	B	0.2	0.2	0.3
$S0_4$	Sulfate	mg/L	300.0	B	1.4	102	110
TPH	Heavy Oil	mg/L	8015DRO	B	A	A	A
NO_2	Nitrite	mg/L	A	B	A	A	A
Al	Aluminum	ug/L	A	B	A	A	A
As	Arsenic	ug/L	200.8	B	< 1	1.3	1
Ba	Barium	ug/L	A	B	A	A	A
Ca	Calcium	ug/L	200.8	B	A	A	A
Cd	Cadmium	ug/L	200.8	B	< 0.2	0.4	0.3
Cr	Chromium	ug/L	200.8	B	3.1	6.8	3.3
Cu	Copper	ug/L	200.8	B	1.2	4.4	4
Fe	Iron	ug/L	200.7	B	A	A	A
Hg	Mercury	ng/L	**1631	B	A	A	A
K	Potassium	ug/L	200.7	B	A	A	A
Li	Lithium	ug/L	A	B	A	A	A
Mg	Magnesium	ug/L	200.7	B	A	A	A
Na	Sodium	ug/L	200.7	B	A	A	A
Ni	Nickel	ug/L	200.8	B	< 2	6	6.2
Pb	Lead	ug/L	200.8	B	< 1	1.3	< 1
Tl	Thallium	ug/L	A	B	A	A	A
V	Vanadium	ug/L	A	B	A	A	A
Zn	Zinc	ug/L	200.8	B	<5	20	6.6
Al	Dissolved Aluminum	ug/L	A	B	A	A	A
As	Dissolved Arsenic	ug/L	200.8	B	2.1	<1	<1
Ba	Dissolved Barium	ug/L	A	B	A	A	A
Ca	Dissolved Calcium	ug/L	200.7	B	A	A	A
Cd	Dissolved Cadmium	ug/L	200.8	B	<0.2	<0.2	0.5
Cr	Dissolved Chromium	ug/L	200.8	B	3.7	1.2	<1
Cu	Dissolved Copper	ug/L	200.8	B	1	2	1.2
Fe	Dissolved Iron	ug/L	200.7	B	A	A	A
Hg	Dissolved Mercury	ng/L	**1631	B	A	A	A
K	Dissolved Potassium	ug/L	200.7	B	A	A	A
Li	Dissolved Lithium	ug/L	A	B	A	A	A
Mg	Dissolved Magnesium	ug/L	200.7	B	A	A	A
Na	Dissolved Sodium	ug/L	200.7	B	A	A	A
Ni	Dissolved Nickel	ug/L	200.8	B	<2	2.4	6.2
Pb	Dissolved Lead	ug/L	200.8	B	<1	<1	<1
Tl	Dissolved Thallium	ug/L	A	B	A	A	A
V	Dissolved Vanadium	ug/L	A	B	A	A	A
Zn	Dissolved Zinc	ug/L	200.8	B	<5	<5	<5
Plot Size	Plot Size	Hectares		B	0.494208	0.494208	0.494208
Rainfall Depth	Depth of Rainfall	mm		B	64.77	11.94	18.29
Rainfall Duration	Duration of Storm Event	min		B	2880	360	600
Runoff Volume	Volume of Water Collected	L		B	12431.86	7759.29	D
Sediment Capture	Weight of Sediment Collected	kg		B	A	A	A
Total Rate of Sediment Capture	(TSS + Sediment Capture)/Runoff Volume	kg/L		B	A	A	A
Runoff Rate	Runoff Volume / Plot Size	L/Hectare		B	25155.11687	15700.45406	A
Erosion Rate	Weight of Sediment collected / Plot Size	kg/Hectare		B	A	A	A
Total Erosion Rate	Total Rate of Sediment Capture X Runoff Rate	kg/Hectare		B	A	A	A

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1hectare = 2.47104acres
0.454kg = 1lb

Test Material: Ultra Tack

Application Rate: 28.0463 kg/hectare

San Diego State University Soil Erosion Reasearch Laboratory Storm Event				Site/Design Storm Date Soil Type					
Parameter	Description	Units	EPA Test Number	SERL/ 10 Year 1 coarse	SERL/10 Year 2 coarse	SERL/ 10 Year 1&2 MEAN coarse	SERL/ 10 Year 1 August 3, 2001 fine	SERL/10 Year 2 August 4, 2001 fine	SERL/10 Year 1&2 MEAN fine
pH		pH units	150.1	6.67	7.46	7.065	7.31	7.29	7.30
EC	Specifc Conductivity	umhos/cm	A	A	A	A	A	A	A
TSS	Total Susspended Solids	mg/L	160.2	232	928.00	580	149.00	1316.00	732.50
TDS	Total Dissolved Solids	mg/L	A	A	A	A	A	A	A
Hardness	as $CaCO_3$	mg/L	A	A	A	A	A	A	A
BOD	Biological Oxygen Demand	mg/L	405.1	66	6.00	36	54.50	10.30	32.40
COD	Chemical Oxygen Demand	mg/L	A	254	26.00	140	238.00	85.80	161.90
DOC	Dissolved Organic Carbon	mg/L	A	A	A	A	A	A	A
TOC	Total Organic Carbon	mg/L	415.2	77.6	11.00	44.3	57.30	20.10	38.70
NO_3	as Nitrogen	mg/L	353.3	0.11	0.10	0.105	<0.1	1.86	D
TKN	Total Kjedahl Nitrogen	mg/L	351.4	15.2	1.53	8.365	6.47	11.60	9.04
P	Phosphorous	mg/L	365.2	0.05	0.06	0.055	0.08	0.09	0.09
Ortho-P	Dissolved Ortho-Phosphate	mg/L	A	A	A	A	A	A	A
NH_3-N	Ammonia	mg/L	A	A	A	A	A	A	A
$S0_4$	Sulfate	mg/L	A	A	A	A	A	A	A
TPH	Heavy Oil	mg/L	A	A	A	A	A	A	A
NO_2	Nitrite	mg/L	354.1	<0.05	<0.05	D	<0.05	<0.05	D
Al	Aluminum	ug/L	200.7	A	A	A	A	A	A
As	Arsenic	ug/L	206.2	A	A	A	A	A	A
Ba	Barium	ug/L	200.7	A	A	A	A	A	A
Ca	Calcium	ug/L	200.7	A	A	A	A	A	A
Cd	Cadmium	ug/L	200.7	A	A	A	A	A	A
Cr	Chromium	ug/L	200.7	A	A	A	A	A	A
Cu	Copper	ug/L	200.7	A	A	A	A	A	A
Fe	Iron	ug/L	200.7	A	A	A	A	A	A
Hg	Mercury	ng/L	245.1	A	A	A	A	A	A
K	Potassium	ug/L	A	A	A	A	A	A	A
Li	Lithium	ug/L	200.7	A	A	A	A	A	A
Mg	Magnesium	ug/L	200.7	A	A	A	A	A	A
Na	Sodium	ug/L	A	A	A	A	A	A	A
Ni	Nickel	ug/L	200.7	A	A	A	A	A	A
Pb	Lead	ug/L	200.7	A	A	A	A	A	A
Tl	Thallium	ug/L	279.2	A	A	A	A	A	A
V	Vanadium	ug/L	200.7	A	A	A	A	A	A
Zn	Zinc	ug/L	200.7	A	A	A	A	A	A
Al	Dissolved Aluminum	ug/L	200.7	660	110	385	390.00	780.00	585.00
As	Dissolved Arsenic	ug/L	206.2	10	<10	D	<10	<10	D
Ba	Dissolved Barium	ug/L	200.7	40	50	45	40.00	130.00	85.00
Ca	Dissolved Calcium	ug/L	200.7	32000	25100	28550	80300.00	265000.00	172650.00
Cd	Dissolved Cadmium	ug/L	200.7	<20	<20	D	<20	<20	D
Cr	Dissolved Chromium	ug/L	200.7	<10	<10	D	<10	<10	D
Cu	Dissolved Copper	ug/L	200.7	<10	<10	D	<10	<10	D
Fe	Dissolved Iron	ug/L	200.7	550	<50	D	130.00	230.00	180.00
Hg	Dissolved Mercury	ng/L	245.1	<2000	<2000	D	<2000	<2000	D
K	Dissolved Potassium	ug/L	A	A	A	A	A	A	A
Li	Dissolved Lithium	ug/L	200.7	<20	<20	D	<20	<20	D
Mg	Dissolved Magnesium	ug/L	200.7	6790	5150	5970	27800.00	57500.00	42650.00
Na	Dissolved Sodium	ug/L	A	A	A	A	A	A	A
Ni	Dissolved Nickel	ug/L	200.7	70	<40	D	<40	<40	D
Pb	Dissolved Lead	ug/L	200.7	<100	<100	D	<100	<100	D
Tl	Dissolved Thallium	ug/L	279.2	<100	<100	D	<100	<100	D
V	Dissolved Vanadium	ug/L	200.7	<20	<20	D	<20	<20	D
Zn	Dissolved Zinc	ug/L	200.7	160	<20	D	250.00	140.00	195.00
Plot Size	Plot Size	Hectares		0.0016	0.0016	0.0016	0.0016	0.0016	0.0016
Rainfall Depth	Depth of Rainfall	mm		31.67	31.67	31.67	31.67	31.67	31.67
Rainfall Duration	Duration of Storm Event	min		100	100	100	100	100	100
Runoff Volume	Volume of Water Collected	L		422.85	453.83	438.34	393.49	425.02	409.26
Sediment Capture	Weight of Sediment Collected	kg		0.55	0.73	0.64	0.1	0.11	0.105
Total Rate of Sediment Capture	(TSS + Sediment Capture)/Runoff Volume	kg/L		0.00153	0.00254	0.00203	0.00040	0.00157	0.00099
Runoff Rate	Runoff Volume / Plot Size	L/Hectare		261219.92	280358.13	270789.02	243082.48	262560.46	252821.47
Erosion Rate	Weight of Sediment collected / Plot Size	kg/Hectare		339.77	450.96	395.37	61.78	67.95	64.86
Total Erosion Rate	Total Rate of Sediment Capture X Runoff Rate	kg/Hectare		0.52	1.14	0.83	0.02	0.11	0.07

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3.785L = 1gal
1hectare = 2.47104acres
0.454kg = 1lb

Test Material: PAM

Application Rate: 2.2437 - 5.60926 kg/hectare

Parameter	Description	Units	EPA Test Number	TPSSES Storm Event – Site/Plot, Date, Soil Type: 73S/12-208 February 12,2001 fine	73S/12-208 February 24-26,2001 fine	73S/12-208 March 6,2001 fine	73S/12-208 April 7,2001 fine
pH		pH units	150.1	B	10	C	8
EC	Specifc Conductivity	umhos/cm	120.1	B	150	C	457
TSS	Total Susspended Solids	mg/L	160.2	B	970	C	4096
TDS	Total Dissolved Solids	mg/L	160.1	B	144	C	454
Hardness	as $CaCO_3$	mg/L	130.2	B	26	C	277
BOD	Biological Oxygen Demand	mg/L	405.1	B	21	C	< 3
COD	Chemical Oxygen Demand	mg/L	410.4	B	62	C	6
DOC	Dissolved Organic Carbon	mg/L	415.1	B	15	C	6.3
TOC	Total Organic Carbon	mg/L	415.1	B	16	C	7
NO_3	as Nitrogen	mg/L	300.0	B	< 0.1	C	0.3
TKN	Total Kjedahl Nitrogen	mg/L	351.3	B	0.4	C	3.8
P	Phosphorous	mg/L	365.2	B	3.3	C	0.17
Ortho-P	Dissolved Ortho-Phosphate	mg/L	365.2	B	0.1	C	0.05
NH_3-N	Ammonia	mg/L	350.2	B	0.2	C	0.3
$S0_4$	Sulfate	mg/L	300.0	B	1.4	C	225
TPH	Heavy Oil	mg/L	8015DRO	B	A	C	A
NO_2	Nitrite	mg/L	A	A	A	C	A
Al	Aluminum	ug/L	A	B	A	C	A
As	Arsenic	ug/L	200.8	B	2.5	C	14
Ba	Barium	ug/L	A	B	A	C	A
Ca	Calcium	ug/L	200.8	B	A	C	A
Cd	Cadmium	ug/L	200.8	B	0.8	C	5.2
Cr	Chromium	ug/L	200.8	B	27	C	139
Cu	Copper	ug/L	200.8	B	8.7	C	48
Fe	Iron	ug/L	200.7	B	A	C	A
Hg	Mercury	ng/L	**1631	B	A	C	A
K	Potassium	ug/L	200.7	B	A	C	A
Li	Lithium	ug/L	A	B	A	C	A
Mg	Magnesium	ug/L	200.7	B	A	C	A
Na	Sodium	ug/L	200.7	B	A	C	A
Ni	Nickel	ug/L	200.8	B	14	C	86
Pb	Lead	ug/L	200.8	B	4.7	C	27
Tl	Thallium	ug/L	A	B	A	C	A
V	Vanadium	ug/L	A	B	A	C	A
Zn	Zinc	ug/L	200.8	B	68	C	374
Al	Dissolved Aluminum	ug/L	A	B	A	C	A
As	Dissolved Arsenic	ug/L	200.8	B	2.1	C	<1
Ba	Dissolved Barium	ug/L	A	B	A	C	A
Ca	Dissolved Calcium	ug/L	200.7	B	A	C	A
Cd	Dissolved Cadmium	ug/L	200.8	B	<0.2	C	0.5
Cr	Dissolved Chromium	ug/L	200.8	B	3.7	C	<1
Cu	Dissolved Copper	ug/L	200.8	B	1	C	1.2
Fe	Dissolved Iron	ug/L	200.7	B	A	C	A
Hg	Dissolved Mercury	ng/L	**1631	B	A	C	A
K	Dissolved Potassium	ug/L	200.7	B	A	C	A
Li	Dissolved Lithium	ug/L	A	B	A	C	A
Mg	Dissolved Magnesium	ug/L	200.7	B	A	C	A
Na	Dissolved Sodium	ug/L	200.7	B	A	C	A
Ni	Dissolved Nickel	ug/L	200.8	B	<2	C	6.2
Pb	Dissolved Lead	ug/L	200.8	B	<1	C	<1
Tl	Dissolved Thallium	ug/L	A	B	A	C	A
V	Dissolved Vanadium	ug/L	A	B	A	C	A
Zn	Dissolved Zinc	ug/L	200.8	B	<5	C	<5
Plot Size	Plot Size	Hectares		B	0.494208	C	0.494208
Rainfall Depth	Depth of Rainfall	mm		B	62.74	C	15.75
Rainfall Duration	Duration of Storm Event	min		B	2880	C	600
Runoff Volume	Volume of Water Collected	L		B	1953.98	C	2265.49
Sediment Capture	Weight of Sediment Collected	kg		B	A	C	A
Total Rate of Sediment Capture	(TSS + Sediment Capture)/Runoff Volume	kg/L		B	A	C	A
Runoff Rate	Runoff Volume / Plot Size	L/Hectare		B	3953.76036	C	4584.082006
Erosion Rate	Weight of Sediment collected / Plot Size	kg/Hectare		B	A	C	A
Total Erosion Rate	Total Rate of Sediment Capture X Runoff Rate	kg/Hectare		B	A	C	A

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3.785L = 1gal
1hectare = 2.47104acres
0.454kg = 1lb

Test Material: PAM

Application Rate: 2.2437 - 5.60926 kg/hectare

Parameter	Description	EPA Test Number	San Diego State University Soil Erosion Reasearch Laboratory Storm Event – Site/Design Storm, Date, Soil Type: SERL/ 10 Year 1 August 28, 2001 coarse	SERL/10 Year 2 August 29, 2001 coarse	SERL/ 10 Year 1&2 MEAN coarse	SERL/ 10 Year 1 July 20, 2001 fine	SERL/10 Year 2 July 21, 2001 fine	SERL/10 Year 1&2 MEAN fine
pH		150.1	8.52	8.82	8.67	8.33	8.33	8.33
EC	Specifc Conductivity	A	A	A	A	A	A	A
TSS	Total Susspended Solids	160.2	15676	42866.00	29271	37458.50	35588.67	36523.58
TDS	Total Dissolved Solids	A	A	A	A	A	A	A
Hardness	as $CaCO_3$	A	A	A	A	A	A	A
BOD	Biological Oxygen Demand	405.1	3	2.00	2.5	5.60	3.00	4.30
COD	Chemical Oxygen Demand	A	34	27.00	30.5	157.00	30.33	93.67
DOC	Dissolved Organic Carbon	A	A	A	A	A	A	A
TOC	Total Organic Carbon	415.2	6.3	2.30	4.3	7.20	3.90	5.55
NO_3	as Nitrogen	353.3	1.47	0.60	1.035	0.68	1.38	1.03
TKN	Total Kjedahl Nitrogen	351.4	19.4	20.70	20.05	10.09	<1.0	D
P	Phosphorous	365.2	0.06	0.23	0.145	0.05	0.09	0.07
Ortho-P	Dissolved Ortho-Phosphate	A	A	A	A	A	A	A
NH_3-N	Ammonia	A	A	A	A	A	A	A
$S0_4$	Sulfate	A	A	A	A	A	A	A
TPH	Heavy Oil	A	A	A	A	A	A	A
NO_2	Nitrite	354.1	0.12	<0.05	D	0.19	0.19	0.19
Al	Aluminum	200.7	A	A	A	A	A	A
As	Arsenic	206.2	A	A	A	A	A	A
Ba	Barium	200.7	A	A	A	A	A	A
Ca	Calcium	200.7	A	A	A	A	A	A
Cd	Cadmium	200.7	A	A	A	A	A	A
Cr	Chromium	200.7	A	A	A	A	A	A
Cu	Copper	200.7	A	A	A	A	A	A
Fe	Iron	200.7	A	A	A	A	A	A
Hg	Mercury	245.1	A	A	A	A	A	A
K	Potassium	A	A	A	A	A	A	A
Li	Lithium	200.7	A	A	A	A	A	A
Mg	Magnesium	200.7	A	A	A	A	A	A
Na	Sodium	A	A	A	A	A	A	A
Ni	Nickel	200.7	A	A	A	A	A	A
Pb	Lead	200.7	A	A	A	A	A	A
Tl	Thallium	279.2	A	A	A	A	A	A
V	Vanadium	200.7	A	A	A	A	A	A
Zn	Zinc	200.7	A	A	A	A	A	A
Al	Dissolved Aluminum	200.7	300	200	250	325.83	553.33	439.58
As	Dissolved Arsenic	206.2	20	10	15	<10	<10	D
Ba	Dissolved Barium	200.7	70	39	54.5	40.00	26.67	33.33
Ca	Dissolved Calcium	200.7	52300	14100	33200	143766.67	23516.67	83641.67
Cd	Dissolved Cadmium	200.7	<20	<20	D	30.00	<20	D
Cr	Dissolved Chromium	200.7	20	<10	D	20.00	20.00	20.00
Cu	Dissolved Copper	200.7	<10	20	D	10.00	10.00	10.00
Fe	Dissolved Iron	200.7	<50	150	D	66.00	84.00	75.00
Hg	Dissolved Mercury	245.1	<2000	<2000	D	<2000	<2000	D
K	Dissolved Potassium	A	A	A	A	A	A	A
Li	Dissolved Lithium	200.7	<20	<20	D	70.00	<20	D
Mg	Dissolved Magnesium	200.7	10400	2600	6500	58291.67	8966.67	33629.17
Na	Dissolved Sodium	A	A	A	A	A	A	A
Ni	Dissolved Nickel	200.7	<40	<40	D	<40	<40	D
Pb	Dissolved Lead	200.7	<100	<100	D	140.00	<100	D
Tl	Dissolved Thallium	279.2	<100	<100	D	<100	<100	D
V	Dissolved Vanadium	200.7	<20	<20	D	<20	<20	D
Zn	Dissolved Zinc	200.7	<20	30	D	27.92	30.00	28.96
Plot Size	Plot Size		0.0016	0.0016	0.0016	0.0016	0.0016	0.0016
Rainfall Depth	Depth of Rainfall		31.67	31.67	31.67	31.67	31.67	31.67
Rainfall Duration	Duration of Storm Event		100	100	100	100	100	100
Runoff Volume	Volume of Water Collected		428.87	405.93	417.4	480.73	514.96	497.85
Sediment Capture	Weight of Sediment Collected		30.51	26.53	28.52	67.17	45.53	56.35
Total Rate of Sediment Capture	(TSS + Sediment Capture)/Runoff Volume		0.08682	0.10822	0.09752	0.17718	0.12400	0.15059
Runoff Rate	Runoff Volume / Plot Size		264938.83	250767.41	257853.12	296975.88	318121.81	307548.84
Erosion Rate	Weight of Sediment collected / Plot Size		18847.86	16389.18	17618.52	41494.96	28126.62	34810.79
Total Erosion Rate	Total Rate of Sediment Capture X Runoff Rate		1636.30	1773.67	1704.99	7352.22	3487.79	5420.01

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D = Below Limit of Detection
N/A = Not Applicable

3.785L = 1gal
1hectare = 2.47104acres
0.454kg = 1lb

Test Material: Top Coat

Application Rate: 3926.48 kg/hectare

TPSSES Storm Event

Parameter	Description	Units	EPA Test Number	73S/12-209 February 12,2001 fine	73S/12-209 February 24-26,2001 fine	73S/12-209 March 6,2001 fine	73S/12-209 April 7,2001 fine
				Site/Plot Date Soil Type			
pH		pH units	150.1	B	10.1	C	8
EC	Specifc Conductivity	umhos/cm	120.1	B	152	C	308
TSS	Total Susspended Solids	mg/L	160.2	B	361	C	278
TDS	Total Dissolved Solids	mg/L	160.1	B	144	C	288
Hardness	as $CaCO_3$	mg/L	130.2	B	41	C	117
BOD	Biological Oxygen Demand	mg/L	405.1	B	24	C	12
COD	Chemical Oxygen Demand	mg/L	410.4	B	60	C	36
DOC	Dissolved Organic Carbon	mg/L	415.1	B	12	C	16
TOC	Total Organic Carbon	mg/L	415.1	B	13	C	17
NO_3	as Nitrogen	mg/L	300.0	B	< 0.1	C	< 0.1
TKN	Total Kjedahl Nitrogen	mg/L	351.3	B	0.8	C	1.2
P	Phosphorous	mg/L	365.2	B	0.98	C	0.29
Ortho-P	Dissolved Ortho-Phosphate	mg/L	365.2	B	< 0.03	C	0.11
NH_3-N	Ammonia	mg/L	350.2	B	0.2	C	A
SO_4	Sulfate	mg/L	300.0	B	8	C	122
TPH	Heavy Oil	mg/L	8015DRO	B	A	C	A
NO_2	Nitrite	mg/L	A	B	A	C	A
Al	Aluminum	ug/L	A	B	A	C	A
As	Arsenic	ug/L	200.8	B	1.1	C	1.6
Ba	Barium	ug/L	A	B	A	C	A
Ca	Calcium	ug/L	200.8	B	A	C	A
Cd	Cadmium	ug/L	200.8	B	0.2	C	0.3
Cr	Chromium	ug/L	200.8	B	9.3	C	9.4
Cu	Copper	ug/L	200.8	B	3.2	C	5.5
Fe	Iron	ug/L	200.7	B	A	C	A
Hg	Mercury	ng/L	**1631	B	A	C	A
K	Potassium	ug/L	200.7	B	A	C	A
Li	Lithium	ug/L	A	B	A	C	A
Mg	Magnesium	ug/L	200.7	B	A	C	A
Na	Sodium	ug/L	200.7	B	A	C	A
Ni	Nickel	ug/L	200.8	B	4.2	C	5.8
Pb	Lead	ug/L	200.8	B	1.6	C	2.1
Tl	Thallium	ug/L	A	B	A	C	A
V	Vanadium	ug/L	A	B	A	C	A
Zn	Zinc	ug/L	200.8	B	375	C	22
Al	Dissolved Aluminum	ug/L	A	B	A	C	A
As	Dissolved Arsenic	ug/L	200.8	B	1	C	<1
Ba	Dissolved Barium	ug/L	A	B	A	C	A
Ca	Dissolved Calcium	ug/L	200.7	B	A	C	A
Cd	Dissolved Cadmium	ug/L	200.8	B	<0.2	C	<0.2
Cr	Dissolved Chromium	ug/L	200.8	B	2.5	C	<1
Cu	Dissolved Copper	ug/L	200.8	B	<1	C	<1
Fe	Dissolved Iron	ug/L	200.7	B	A	C	A
Hg	Dissolved Mercury	ng/L	**1631	B	A	C	A
K	Dissolved Potassium	ug/L	200.7	B	A	C	A
Li	Dissolved Lithium	ug/L	A	B	A	C	A
Mg	Dissolved Magnesium	ug/L	200.7	B	A	C	A
Na	Dissolved Sodium	ug/L	200.7	B	A	C	A
Ni	Dissolved Nickel	ug/L	200.8	B	<2	C	<2
Pb	Dissolved Lead	ug/L	200.8	B	<1	C	<1
Tl	Dissolved Thallium	ug/L	A	B	A	C	A
V	Dissolved Vanadium	ug/L	A	B	A	C	A
Zn	Dissolved Zinc	ug/L	200.8	B	<5	C	<5
Plot Size	Plot Size	Hectares		B	0.494208	C	0.494208
Rainfall Depth	Depth of Rainfall	mm		B	68.07	C	16.26
Rainfall Duration	Duration of Storm Event	min		B	2880	C	600
Runoff Volume	Volume of Water Collected	L		B	4672.57	C	538.05
Sediment Capture	Weight of Sediment Collected	kg		B	A	C	A
Total Rate of Sediment Capture	(TSS + Sediment Capture)/Runoff Volume	kg/L		B	A	C	A
Runoff Rate	Runoff Volume / Plot Size	L/Hectare		B	9454.662814	C	1088.711636
Erosion Rate	Weight of Sediment collected / Plot Size	kg/Hectare		B	A	C	A
Total Erosion Rate	Total Rate of Sediment Capture X Runoff Rate	kg/Hectare		B	A	C	A

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1hectare = 2.47104acres
0.454kg = 1lb

Test Material: Top Coat

Application Rate: 3926.48 kg/hectare

San Diego State University Soil Erosion Reasearch Laboratory Storm Event

Parameter	Description	Units	EPA Test Number	SERL/ 10 Year 1 August 30, 2001 coarse	SERL/10 Year 2 August 31, 2001 coarse	SERL/ 10 Year 1&2 MEAN coarse	SERL/ 10 Year 1 July 31, 2001 fine	SERL/10 Year 2 August 1, 2001 fine	SERL/10 Year 1&2 MEAN fine
				Site/Design Storm Date Soil Type					
pH		pH units	150.1	8.21	7.81	8.01	8.03	7.70	7.87
EC	Specifc Conductivity	umhos/cm	A	A	A	A	A	A	A
TSS	Total Susspended Solids	mg/L	160.2	7598	10738.00	9168	5839.00	11147.00	8493.00
TDS	Total Dissolved Solids	mg/L	A	A	A	A	A	A	A
Hardness	as $CaCO_3$	mg/L	A	A	A	A	A	A	A
BOD	Biological Oxygen Demand	mg/L	405.1	101	86.00	93.5	72.00	80.00	76.00
COD	Chemical Oxygen Demand	mg/L	A	89	39.00	64	133.00	46.90	89.95
DOC	Dissolved Organic Carbon	mg/L	A	A	A	A	A	A	A
TOC	Total Organic Carbon	mg/L	415.2	22	9.80	15.9	18.90	9.73	14.32
NO_3	as Nitrogen	mg/L	353.3	0.59	0.10	0.345	0.29	<0.10	D
TKN	Total Kjedahl Nitrogen	mg/L	351.4	9.92	7.33	8.625	5.24	6.47	5.86
P	Phosphorous	mg/L	365.2	0.05	0.09	0.07	0.06	0.07	0.07
Ortho-P	Dissolved Ortho-Phosphate	mg/L	A	A	A	A	A	A	A
NH_3-N	Ammonia	mg/L	A	A	A	A	A	A	A
SO_4	Sulfate	mg/L	A	A	A	A	A	A	A
TPH	Heavy Oil	mg/L	A	A	A	A	A	A	A
NO_2	Nitrite	mg/L	354.1	0.65	<0.05	D	<0.05	<0.05	D
Al	Aluminum	ug/L	200.7	A	A	A	A	A	A
As	Arsenic	ug/L	206.2	A	A	A	A	A	A
Ba	Barium	ug/L	200.7	A	A	A	A	A	A
Ca	Calcium	ug/L	200.7	A	A	A	A	A	A
Cd	Cadmium	ug/L	200.7	A	A	A	A	A	A
Cr	Chromium	ug/L	200.7	A	A	A	A	A	A
Cu	Copper	ug/L	200.7	A	A	A	A	A	A
Fe	Iron	ug/L	200.7	A	A	A	A	A	A
Hg	Mercury	ng/L	245.1	A	A	A	A	A	A
K	Potassium	ug/L	A	A	A	A	A	A	A
Li	Lithium	ug/L	200.7	A	A	A	A	A	A
Mg	Magnesium	ug/L	200.7	A	A	A	A	A	A
Na	Sodium	ug/L	A	A	A	A	A	A	A
Ni	Nickel	ug/L	200.7	A	A	A	A	A	A
Pb	Lead	ug/L	200.7	A	A	A	A	A	A
Tl	Thallium	ug/L	279.2	A	A	A	A	A	A
V	Vanadium	ug/L	200.7	A	A	A	A	A	A
Zn	Zinc	ug/L	200.7	A	A	A	A	A	A
Al	Dissolved Aluminum	ug/L	200.7	320	210	265	600.00	570.00	585.00
As	Dissolved Arsenic	ug/L	206.2	10	10	10	30.00	<10	#VALUE!
Ba	Dissolved Barium	ug/L	200.7	60	60	60	50.00	40.00	45.00
Ca	Dissolved Calcium	ug/L	200.7	370000	193000	281500	535000.00	619000.00	577000.00
Cd	Dissolved Cadmium	ug/L	200.7	<20	<20	D	<20	<20	D
Cr	Dissolved Chromium	ug/L	200.7	20	<10	D	<10	<10	D
Cu	Dissolved Copper	ug/L	200.7	<10	<10	D	<10	<10	D
Fe	Dissolved Iron	ug/L	200.7	<50	150	D	1560.00	50.00	805.00
Hg	Dissolved Mercury	ng/L	245.1	<2000	<2000	D	<2000	<2000	D
K	Dissolved Potassium	ug/L	A	A	A	A	A	A	A
Li	Dissolved Lithium	ug/L	200.7	<20	<20	D	<20	<20	D
Mg	Dissolved Magnesium	ug/L	200.7	26000	2600	14300	72300.00	87000.00	79650.00
Na	Dissolved Sodium	ug/L	A	A	A	A	A	A	A
Ni	Dissolved Nickel	ug/L	200.7	<40	<40	D	<40	<40	D
Pb	Dissolved Lead	ug/L	200.7	<100	<100	D	<100	<100	D
Tl	Dissolved Thallium	ug/L	279.2	<100	<100	D	<100	<100	D
V	Dissolved Vanadium	ug/L	200.7	<20	<20	D	<20	<20	D
Zn	Dissolved Zinc	ug/L	200.7	60	26000	13030	40.00	140.00	D
Plot Size	Plot Size	Hectares		0.0016	0.0016	0.0016	0.0016	0.0016	0.0016
Rainfall Depth	Depth of Rainfall	mm		31.67	31.67	31.67	31.67	31.67	31.67
Rainfall Duration	Duration of Storm Event	min		100	100	100	100	100	100
Runoff Volume	Volume of Water Collected	L		315.22	393.17	354.195	319.61	405.85	362.73
Sediment Capture	Weight of Sediment Collected	kg		8.52	9.15	8.835	10.83	19.75	15.29
Total Rate of Sediment Capture	(TSS + Sediment Capture)/Runoff Volume	kg/L		0.03463	0.03401	0.03432	0.03972	0.05981	0.04977
Runoff Rate	Runoff Volume / Plot Size	L/Hectare		194730.38	242884.79	218807.59	197442.35	250717.99	224080.17
Erosion Rate	Weight of Sediment collected / Plot Size	kg/Hectare		5263.32	5652.51	5457.91	6690.34	12200.76	9445.55
Total Erosion Rate	Total Rate of Sediment Capture X Runoff Rate	kg/Hectare		182.25	192.24	187.25	265.77	729.73	497.75

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N/A = Not Applicable

3.785L = 1gal
1hectare = 2.47104acres
0.454kg = 1lb

D-TEK Analytical Laboratories, Inc.
9020 Kenamar Drive, Suite 205
SAN DIEGO, CA 92121
(858) 566-4540, FAX (858) 566-4542

CHAIN OF CUSTODY

DATE: __________ PAGE _____ OF _____

D-TEK LOG #: ________________ TO #: ____________________

CUSTOMER INFORMATION	PROJECT INFORMATION
COMPANY: CONTACT PERSON:	PROJECT NAME/NUMBER
PROJECT MANAGER:	**BILLING INFORMATION**
ADDRESS: CITY: ZIP:	BILL TO:
PHONE:	ADDRESS:
FAX:	PHONE:
	P.O.#:

D-TEK LOG #	SAMPLE # / SAMPLE IDENTIFICATION	SAMPLE DATE	SAMPLE TIME	SAMPLE MATRIX	CONTAIN TYPE	# OF CONTAINERS	ANALYSIS REQUEST											

SAMPLE INTEGRITY													
	MEETS HOLDING TIME ?	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N
	CORRECT CONTAINERS ?	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N

1. RELINQUISHED BY	2. RELINQUISHED BY	3. RELINQUISHED BY	SAMPLE RECEIPT	SPECIAL INSTRUCTIONS
DATE AND TIME:	DATE AND TIME:	DATE AND TIME:	RECEIVED IN ICE? YES/NO	
SIGNATURE:	SIGNATURE:	SIGNATURE:	TAPE SEAL INTACT Y/N NA	
PRINTED NAME:	PRINTED NAME:	PRINTED NAME:	PRESERVATIVE YES/NO NA	
1. RECEIVED BY	**2. RECEIVED BY**	**3. RECEIVED BY**	**PRECAUTIONS:**	
DATE AND TIME:	DATE AND TIME:	DATE AND TIME:		
SIGNATURE:	SIGNATURE:	SIGNATURE:		
PRINTED NAME:	PRINTED NAME:	PRINTED NAME:		TAT

-- ALL SAMPLES ARE SUBJECT TO TERMS AND CONDITIONS ON REVERSE SIDE --

CALTRANS LABORATORY CORRELATION STUDY 2001

NOVEMBER 2001

Prepared for:
CALIFORNIA DEPARTMENT OF TRANSPORTATION
SACRAMENTO, CALIFORNIA

Tables

Figures

Graphs

Appendices

The primary objective of the Laboratory Correlation Study (LCS) was to assess the consistency of soil erosion and water-quality measurements taken in the field through the Temporary/Permanent Soil Stabilization Evaluation Study (TPSSES) and at the SDSU Soil Erosion Research Laboratory (SDSU/SERL) when seven hydraulically-applied erosion control products were applied to “fine” and “course” soil plots. A secondary project goal – if a correlation between field and laboratory studies was established - was to use erosion control performance and water quality data to make statewide recommendations on specification and use of the hydraulic practices that were tested.

Differences in study design between the TPSSES and the normal SDSU/SERL procedures appear to have had an adverse effect on establishing a relationship between field and laboratory results. In addition, gaps in the field data collection occurred due to failure of the sequential samplers during storm events and the fact that all hydraulic materials were not applied at the same time.

Differences between the field and laboratory plot sizes, rainfall amounts and storm duration appear to have influenced the differential performance of the various products tested. However, there was not sufficient data to determine the effects of these variables on water quality and the design of the two experiments did not allow these effects to be estimated. It appears that in particular, rainfall amounts of the two experiments were so different that water quality measurements may be due to differences in the rainfall amounts of the experiments.

The correlation between the SDSU/SERL and the TPSSES values were calculated for each water quality measurement separately. As a result:

1) Only total suspended solids (TSS) and total organic carbon (TOC) show reasonable correlation of lab and field data with R-squared values of 52.7% and 36.5%
2) Although the R-squared values for *dFe* and *dMg* are moderately large, these values are artificially inflated by the small number of data points available for analysis
3) Logarithmic transformations of the data were explored but did not increase the correlation of the measurements: all R-squared values remained below 25%.
4) Total Suspended Solids exhibited a significant and moderately good correlation between the field and lab measurements when the data was logarithmically transformed. Although there is not perfect agreement of the field and lab values, there is a strong linear correlation in these values (e.g., when the lab values were high, so were the field values; when the lab values were low, so were the field values).
5) All other water-quality measurements show poor correlation of field and lab data.

A direct correlation between indoor laboratory performance and field performance – a relationship that some specifiers or designers might require to approve material usage - was not established as a result of this study. The SDSU study team considers the differences in study design and data collection procedures to account for the apparent lack of correlation.

1.1 PROJECT DESCRIPTION AND OBJECTIVES OF STUDY

The purpose of the California State Department of Transportation (Caltrans) Laboratory Correlation Study (LCS) was to examine the data from the District 7 Erosion Control Pilot Study (ECPS) of June 2000 and the Caltrans Temporary/Permanent Soil Stabilization Evaluation Study (TPSSES) of March 2001, Orange County, California, and to provide a correlation with new information obtained from expanded indoor laboratory testing at the San Diego State University Soil Erosion Research Laboratory (SDSU/SERL).

The SDSU/SERL indoor soil test bed and rainfall simulator has been used extensively to examine the performance of various types of erosion-control best management practices (BMPs). Over the course of the two-year Caltrans ECPS, fourteen different BMPs were installed on one type of soil, a clayey sand. These materials were subjected to a wide range of simulated storm events (e.g. 5-year, 10-year, and 50-year intensities) to evaluate their erosion-control effectiveness and impact on water quality. In contrast, the Caltrans TPSSES was a field experiment that examined the erosion potential of two types of soil–one “coarse” and one “fine”–as well as the erosion-control performance of seven hydraulically applied soil stabilizers over the course of one winter (2001) and under ambient rainfall conditions.

The LCS examined the erosion potential of two distinctly different, custom-blended soils characteristic of the two soils examined in the TPSSES. The LCS also examined the erosion-control effectiveness of the seven hydraulically applied erosion-control products currently under evaluation at the TPSSES Orange County site, which are as follows:

- Earth Guard™
- Soil Sement™
- Airtrol™
- Ultra Tack™
- Chemco™ (PAM)
- Tacking Agent III™
- Topcoat™

The indoor tests at the SDSU/SERL attempted to establish relative performance of the hydraulically applied erosion-control products by measuring soil erosion rate, runoff volume, and sediment delivery. Sampling also included collection of flow-weighted composites for water-quality analysis. Results from the sample analysis were examined to verify and/or compare with existing data from the TPSSES. One of the stated project goals was to make statewide recommendations about whether to use specific erosion-control products based upon erosion-control effectiveness and water-quality impacts.

1.2 PROJECT PERSONNEL

The Consultant Task Order Manager representing San Diego State University was:

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Other key staff include the following:

William Shaddox, Laboratory Supervisor

Sung Mun Jung, Student Assistant Laboratory Supervisor

Lee Harding, Student Laboratory Technician

Chris Nguyen, Student Laboratory Technician

Jon Rynearson, Student Laboratory Technician

Jeff Magsombol , Student Laboratory Technician

Dr. K-J Lui, SDSU Faculty, Statistician

Dr. Colleen Kelly-Clermont, SDSU Faculty, Statistician

Toana Kawashima, Graduate Student Assistant, Statistician

Ellen Atienza, D-Tek Laboratories

Margo Treihaft, Documents and Reports

Richard Rusnak, Student Research Assistant

2.1 TEST FACILTY

SDSU/SERL integrates beneficial features from some of the primary soil erosion research facilities in the United States. Funding for the facility was provided by Caltrans as part of a 1998-2000 erosion-control pilot study, in which design, construction, and operation of the SERL was supervised by URS Greiner Woodward Clyde and SDSU faculty. Actual modification of Industrial Technology Building Room #103 and construction of the soil test bed was carried out by the SDSU Physical Plant (Figure 1).

In designing the SDSU laboratory, members of the Caltrans pilot study team studied the physical layout, testing protocols, and past research activities of the following soil-erosion laboratories:

- Utah Water Research Laboratory (UWRL) at Utah State University, Logan, Utah
- USDA-Agricultural Research Service National Soil Erosion Research Laboratory (NSERL) at Purdue University, West Lafayette, Indiana
- Texas DOT/Texas Transportation Institute (TTI) Hydraulics and Erosion Control Laboratory at Texas A&M, College Station, Texas

The SDSU laboratory is used primarily to provide comparative evaluations of temporary erosion-control practices (e.g., surface mulches, soil-roughening procedures, and liquid soil stabilizers) to baseline, bare-soil conditions under controlled, reproducible, and documented conditions. The SDSU Soil Erosion Research Laboratory is in general conformance with the outlined methods and scope of ASTM D6459, Standard Test Method for Determination of Erosion Control Blanket (ECB) Performance in Protecting Hillslopes from Rainfall Erosion.

2.2 NORTON LADDER RAINFALL SIMULATOR

The rainfall simulation device selected for the SDSU Soil Erosion Laboratory is the Norton Ladder Rainfall Simulator, which was developed at the USDA-ARS National Soil Erosion Research Laboratory by Dr. Darrell Norton (Figure 2). This apparatus has been used worldwide, is reasonably inexpensive, and is easily transported and operated.

For testing in the indoor laboratory, four multiple simulators have been installed in parallel above the soil test bed to uniformly apply precipitation over the entire test plot area (Figure 3). The pre-fabricated rainfall devices were purchased from Advanced Design & Machine (Clarks Hill, Indiana), an experienced manufacturer specializing in producing the Norton simulator.

2.2.1 Physical Characteristics

The basic unit of the simulator is an aluminum frame 5.3 meters (17 feet) long, 0.32 meters (12 inches) wide, and 0.25 meters (10 inches) deep. Each frame is a self-contained unit that includes nozzles, piping, an oscillating mechanism, and a drive motor (Figure 4).

The drop formerly used for the Norton simulator is the Spraying Systems Veejet 80100 nozzle (Figure 5), and the nozzles are spaced 1.1 meters (3.6 feet) apart. For uniform intensity across the plot, the center of spray patterns from two laterally adjacent nozzles meet at the plot surface. This gives a 2.25-mm (.09 in) median drop size, a nozzle exit velocity of 6.8 meters per second (22.3 feet per second), and a spherical drop.

The impact velocities of almost all drops from the Veejet nozzle are nearly equal to the impact velocities of those from natural rainstorms when the nozzle is at least 2.4 meters (7.9 feet) above the soil surface. For this reason, the rainfall simulators used in the SDSU Soil Erosion Laboratory have been installed so that the nozzles are at least 2.5 meters (8.2 feet) above the soil surface. Rainfall intensity can be changed instantaneously with the simulator in operation, and the maximum intensity produced is 135 mm/hr (5.3 in/hr).

2.2.2 Design of Simulated Rainfall

Before testing, the Norton ladder-type simulators are placed into position above the soil test bed. Calibration is achieved by conducting rainfall tests and measuring rainfall volumes in collection devices (Figure 6) placed at precise intervals within the 2 meter by 8 meter (6.5 foot by 26 foot) test plot. A full range of rainfall intensities can be achieved by adjusting one or both of the following parameters:

- The number of sweeps per minute (spm) of the spray nozzles, ranging from 25 to 125 spm (Figure 7).
- Adjusting the water pressure within the supply system. Each simulator has a system of valves that allows internal water pressure to be adjusted from 2 to 6psi. Gauges atop each simulator allow for accurate, manual adjustment (Figure 8).

Simulated rainstorm events used for most of the current testing at the SDSU/SERL have an initial period (Part 1) of low-intensity rainfall, followed by a period (Part 2) of relatively high-intensity rainfall, and ending with a period (Part 3) of relatively low-intensity rainfall.

2.3 SOIL TEST BED

The soil test bed is a 3-meter-wide by 10-meter-long (323 square feet) metal frame that rests on a series of pivots at the lower end of the bed, and which is supported by two hydraulic cylinders near the upper end of the bed (Figure 9). These telescopic cylinders extend to tilt the test bed from its horizontal position to a maximum 1V:2H slope gradient (Figure 10). As a safety precaution, stationary steel support posts are placed beneath the bed when it is raised for rainfall simulations.

The test bed is designed to support a 30.5-cm (1 foot) depth of soil, which is sufficient to allow placement and compaction of soil and the application of various surface erosion-control practices to evaluate their effect on erosion rates.

The sides and ends of the soil test bed are constructed of steel frame-supported 1.0-cm-thick (0.4 in) Plexiglas (Figure 11) that allows ambient light onto the soil surface and facilitates viewing of the effects of rainfall impact and runoff. The total usable surface area of the soil bed is 3 meters (10 feet) wide by 10 meters (33 feet) long, but during testing, only a portion of the treated bed--2 meters wide (6.5 feet) by 8 meters long (26 feet) long--is generally delineated for evaluation by the use of plastic edging (Figure 12). Runoff and sediment are collected at the toe of the slope by a metal flume (Figure 13). Drainage grates have been installed in the floor underneath and at the front of the soil bed, and all runoff not collected is directed to a sanitary sewer.

2.4 HYDRAULIC LIFT SYSTEM

The soil test bed was designed to be lifted hydraulically to the desired slope inclination for testing. Two five-stage, single-acting, telescopic cylinders are positioned approximately 3.0 meters (10 feet) from the top of test bed. The cylinders, which weigh 230 kilograms (505 pounds), each, have a 20.3-cm (8-inch) diameter as the largest moving stage.

The complete hydraulic system consists of the cylinders, a 227-liter (60-gallon) hydraulic fluid reservoir, a 114-lpm (30-gpm) hydraulic pump, and a 50-hp electric motor with motor starter (Figure 14). Also included are a suction strainer, return oil filter, pressure-relief valve, and directional-control valve.

2.5 SEDIMENT COLLECTION SYSTEM

Water and soil runoff from the test bed is collected by plastic edging, flume, and collection containers (Figure 15). The components of the sediment collection system on the test bed are installed before each rainfall simulation. For most erosion-control treatment evaluations, the plastic edging is installed before application of the erosion-control treatment.

2.6 WATER TREATMENT AND STORAGE

To obtain accurate results from the rainfall simulation/erosion-rate evaluations, the municipal water supply is treated by reverse osmosis and softened to remove minerals. This treatment process produces “softer” water that is more similar in quality to natural rainfall. Using municipal water without treatment would cause a decrease in sediment load because minerals in the water serve to decrease erosion.

2.6.1 Water-Treatment System

The water-treatment system (Figure 16) consists of a reverse-osmosis unit, preceded by one activated carbon vessel and two softening vessels arranged in series (i.e., carbon/softener/softener). The system, which is capable of producing 1,140 to 2,270 liters per day (300 to 600 gallons per day), also, includes a pre-filter to remove particulates greater than five microns in size that may escape the service vessels. The system is serviced monthly by a local U.S. Filter representative.

Delivery of water to the rainfall simulators positioned above the soil test bed is by a pump attached to hard plumbing and flexible hoses. A key aspect of the Norton design is that unused water from within the simulators is returned to the holding tank and available for reuse (Figure 17). Flexible plumbing is installed to accommodate this return flow.

2.6.2 Treated Water Storage

Treated water is stored in a 3,785–liter (1,000-gallon) polyethylene storage tank for use in the laboratory simulations (Figure 18). For outdoor test plots, two 757-liter (200–gallon) tanks are truck- or trailer-mounted to deliver treated water to the field for rainfall simulations.

3.1 REVIEW OF TESTING PROCEDURES FOR LCS

A review of current laboratory procedures (developed for the ECPS) was performed to evaluate their adequacy and appropriateness for the LCS. The detailed procedures for soil selection, soil placement in the test bed, erosion-control treatment application, sediment and runoff collection, and operation of the rainfall simulation equipment can be found in the *Laboratory Manual* (URS Greiner Woodward Clyde, 2000b). In brief, the procedures relative to the LCS may be separated into six components, which are as follows:

1. Sizing of test plots
2. Selection of soil type for evaluation
3. Placement of soil material in test bed
4. Test bed preparation for erosion-control material testing
5. Mixing and application of test materials
6. Runoff and sedimentation collection and analysis procedures
7. Water-quality analysis procedures

3.2 SIZING OF TEST PLOTS

The runoff and sedimentation data from the LCS 2 meter by 8 meter test plots is normalized and presented in terms of liters of water and/or kilograms of sediment per hectare. This data is then compared against normalized data from the Orange County study (TPSSES).

3.3 SELECTION OF SOIL TYPE

SDSU evaluated the soil sampling results from Orange County TPSSES field sites to custom-blend two soils for testing at the Soil Erosion Research Laboratory. Once the soils were analyzed, orders for local custom-blending were issued to the supplier, Lakeside Land Company. Before delivery of the custom soil to the SDSU/SERL, soil samples from the supplier were evaluated against the required specifications. These specifications included particle size distribution analysis in accordance with ASTM Methods D2487 and D1140 and Atterburg Limits (liquid limits, plastic limits, and plasticity index) in accordance with ASTM Method D4318 (see Appendix B). The custom-blended soil was then transported to SDSU and stored inside the laboratory until it was placed in the test bed (Figure 19). The characteristics of the soils used in the LCS study are presented in Table 3-1

Table 3-1
CHARACTERISTICS OF SOIL USED FOR LABORATORY CORRELATION STUDY

	Soils From TPSSES Test Sites		Custom Soils for Testing	
	(Soil A)	**(Soil B)**	**(Soil C)**	**(Soil D)**
U.S. Standard	*Olive Yellow*	*Light Olive Brown*	*Lab Soil*	*Mound Clay*
Sieves	*Silty Sand*	*Sandy Clay*	*Clayey Sand*	*Silty Clay*
2”	100	-	-	-
1.5”	96.5	-	-	-
1”	96	100	-	-
3/4”	95	99	-	-
3/8”	94	97	-	-
#4	91	95	93	98
#10	89	92	91	96
#20	85	87	-	-
#40	74	81.5	53	72
#60	57	76	14	62
#140	24	58	11	53
#200	21	55	6	50

3.4 PLACEMENT OF SOIL MATERIAL IN THE TEST BED

Detailed procedures are found in Appendix A. In general, however, the following bed preparation procedures were implemented before the beginning of the testing schedule:

1. Soil was moisturized, tilled, and hand compacted to uniform consistency (Figure 20).
2. Sand cone tests were conducted over random portions of the prepared bed for each new soil type (after it was installed) to determine relative compaction and moisture content of the soil (Figure 21).
3. These tests were conducted immediately after a new soil was introduced into the bed (i.e., coarse or fine).

The introduction of the Soil D (silty clay) into the bed necessitated removal of 30 centimeters (12 inches) of the existing Soil C (clayey sand) from the 2 meter by 8 meter portion of the test bed (Figure 22). Whenever a soil to be tested is changed, the new soil is placed in 10-centimeter (4-inch) lifts and compacted within the excavated portion (30 centimeters by 2 meters by 8 meters) of the bed (Figure 23).

3.5 BED PREPARATION FOR EROSION-CONTROL MATERIAL TESTING

The following bed-preparation procedures were implemented for the evaluation of the hydraulically applied soil stabilizers:

1. Before each new material test (i.e., hydraulically applied soil stabilizer), the soil test bed was placed in the horizontal (flat) position.
2. Wetted soil in the bed (from the previous testing) was removed to expose untested soil, and additional soil was added to replace the soil that was removed (Figure 24).
3. The new soil was moisturized, tilled, and hand compacted to uniform consistency (Figure 25).
4. Edging and flumes were installed to differentiate a 2 meter by 8 meter plot (Figure 26).
5. The selected surface treatment was applied (Figure 27) to each 2 meter by 8 meter plot in a manner consistent with actual field implementation (i.e., rates of application for hydraulic methods similar to those in the Orange County TPSSES (Table 3-1).
6. The hydraulically applied soil stabilizer was allowed to dry for 24 hours.
7. The test bed is raised to a 2:1 slope before rainfall.
8. Rainfall (10 year-2 storm) is introduced and samples are collected (Event 1).
9. The bed is allowed to dry for 24 hours.
10. A second rainfall (10 year-2 storm) is introduced and samples are collected (Event 2).

3.6 MIXING AND APPLICATION OF TEST MATERIALS

Mixing the proper amount of hydraulic soil stabilizer, water, and mulch was accomplished using a Finn T-30 Hydroseeder (Figure 28). The actual amount of materials (e.g., the mixture ratios) was obtained from the TPSSES of March 2001, Orange County, California, and is presented in Table 3-2.

Once the appropriate amount of materials was mixed in the hydroseeder (Figure 29), a rate of flow was determined by taking the average fill time for three 15-liter (4-gallon) buckets (Figure 30). Table 3-3 presents a formula that was developed for determining the time of application (Figure 31). Once the material was applied, it was allowed to dry for 24 hours before the first rain event was applied (Figure 32).

Table 3-2
MIXTURES AND APPLICATION RATES FOR HYDRAULICALLY-APPLIED MATERIALS

Product	Suggested Application Rate	Mix Ratio	Application Rate for Test Plot*
Earth Guard (fine graded soil)	6-7 gal product/acre	6 gal product 3,000 gal water	0.026 gal product 13.0 gal water
Earth Guard (coarse graded soil)	1 gal product/ 0.1 acre 227.5 lbs mulch 300 gal water	1 gal product/ 0.1 acre 227.5 lbs mulch 300 gal water	0.04 gal product 9.1 lbs mulch 12 gal mulch
Soil Sement	670 gal/acre	4:1 ratio water to product	2.68 gal product 10.72 gal water
Tacking Agent III	80 lbs/acre	16 lbs product 500 gal water	0.293 lbs product 9.15 gal water
Airtrol	5000 lbs/acre	1000 lbs product 300 lbs mulch 600 gal water	20 lbs product 6.67 lbs mulch 13.33 gal water
Ultra Tack	25 lbs/acre	5 lbs product 325 lbs mulch 600 gal water	0.1 lbs product 6.5 lbs mulch 12 gal water
PAM (Cytec Superfloc A110)	2 - 5 lbs/acre	5 oz product 400 gal of water	0.014 lbs product 17.92 gal water
Top Coat (Second Nature)	3500 lbs/acre	700 lbs product 1000 gal water	14 lbs product 10.72 gal water

* Based on 0.004-acre plot size

Table 3-3
FORMULA FOR DETERMINING APPLICATION TIME FOR HYDRAULIC PRACTICES

$$T = \frac{W_{hydro} \; x \; MAT_{subplot} \; x \; t_{avg}}{(15.14 \text{ liters}) \; x \; MAT_{hydro}}$$

where:

W_{hydro}	=	volume of water added to the hydroseeder
$MAT_{subplot}$	=	weight of material to be applied to plot
t_{avg}	=	average time to fill a 15 liter (4 gal) bucket
MAT_{hydro}	=	weight of material added to hydroseeder

3.7 RUNOFF AND SEDIMENT COLLECTION AND ANALYSIS PROCEDURES

The procedures for collecting and analyzing runoff water and sediment from the laboratory plots were as follows:

- Runoff and sediment samples were collected in separate 35-gallon containers for Parts 1, 2, and 3 of each storm cycle (Figure 33).
- 500 grams of gypsum were added to aid in settling of sediment (Figure 34).
- The sample containers were allowed to settle overnight.
- The clear supernatant was decanted and the runoff volume recorded (Figure 35).
- A representative sample of the wet sediment was collected for moisture content analysis (Figure 36).
- Based on the calculated moisture content of this sample, the dry weight of the total sediment sample was calculated.

- Samples of wet sediment were weighed and then dried in an oven (Figure 37) to determine gross sediment discharge and erosion rate.

3.8 WATER-QUALITY ANALYSIS PROCEDURES

3.8.1 Manual Sampling Procedures

Water samples were collected to measure the baseline water quality, determine what types of materials leach out of the hydraulic soil stabilizers, and measure the amount of sediment transported in the runoff. The water-quality analyses were conducted according to standard EPA methods.

For each erosion-control treatment, a grab sample of the runoff was collected from each of the three intensity/duration storm components of each test event for analysis (Figure 38). The volume of runoff collected from each of the three storm parts was proportional to the water applied during each storm part to simulate a flow-weighted composite sample (Figure 39). The volume collected for each storm part was as follows:

- Storm Part 1 – 0.5 liters (0.1 gallons), one sample at 15 minutes into the first part of the storm.
- Storm Part 2 – 4 liters (1 gallon), three samples at 10, 20, and 30 minutes into the second part of the storm.
- Storm Part 3 – 0.5 liters (0.1 gallons), one sample at 15 minutes into the third part of the storm.

The basic procedure for water-quality sampling was as follows:

- The sampler put on gloves and other protective gear.
- The sampler obtained a sample collection bottle.
- The sample bottle was inserted into the corner of the flow by hand.
- The sample bottle was filled and then removed by hand.
- The sample bottle was placed in an insulated cooler for transport to the analytical laboratory.

3.8.2 Gloves and Protective Gear

Surgical latex gloves were worn during sample collection to avoid contamination of the sample bottle. Additionally, the gloves provided protection from harmful materials that could be present in the runoff water. One set of gloves was used throughout each storm event. New gloves were used for each subsequent storm test.

3.8.3 Sample Bottle Insertion and Recovery

The sampler manually collected samples by dipping a sample bottle into the water stream running off the plot. To collect the sample, the sampler obtained a clean sample bottle and moved to the sample collection location at the lower end of the simulator bed. At the appropriate time, the sample bottle was placed in the center of the water stream flowing off the simulator bed. Once the bottle was filled to the appropriate (flow proportioned) volume, it was sealed and then placed in the insulated cooler for transport to the analytical laboratory.

3.8.4 Sample Bottles and Volumes

Commercially available, wide-mouth glass bottles were used for collecting the samples.

3.8.5 Paperwork

All water quality samples were accompanied by a standard chain of custody form for D-Tek Analytical Laboratories. (Appendix D) The following information was included on the form: sample identification, sample analysis, sample date and time, as well as the names of all persons responsiblefor the sample.

3.8.6 Preservation

Samples were immediately placed in an insulated cooler following collection and transported to the analytical laboratory. All required preservatives were added to the sample containers by the analytical laboratory.

3.8.7 Holding-Time Limitations

Different analyses have a specified period within which the analysis must be performed. This period is called the *holding time for analysis*. These times place restrictions upon the laboratory analysis; the analytical laboratory was aware of the allowable holding times.

3.8.8 Parameters

The analytical laboratory, D-Tek, combined the three samples collected from each test plot to create a flow-weighted composite sample for analysis for the following constituents:

- pH – EPA Method 150.1
- Biological Oxygen Demand (BOD) – EPA Method 405.1
- Chemical Oxygen Demand (COD) – EPA Method 410.4
- Sixteen Metals (Al, As, Ba, Cd, Ca, Cu, Cr, Fe, Pb, Li, Mg, Hg, Ni, Tm, V, Zn) – Atomic Absorption Spectrophotometry
- Total Organic Carbon (TOC) by TOC Analyzer – EPA Method 415.2

- Total Suspended Solids (TSS) – EPA Method 160.2
- Phosphorus – EPA Method 365.2
- Total Kjedahl Nitrogen (TKN) – EPA Method 351.4
- Nitrate + Nitrite Nitrogen – EPA Methods 353.3/354.1

3.8.9 Water Quality of Reverse Osmosis Treated Water

The SDSU laboratory's reverse osmosis treated water was also analyzed for the same constituents as the test runoff to establish the baseline water quality of the water being used for rainfall simulation.

3.8.10 Sampling for General Water-Quality Indicators

Water samples were analyzed for general water-quality indicators, including pH, BOD, and COD. These analyses provided an indication of the relative acidity/basicity of the water, as well as an indication of the presence of substances that would require oxygen to break them down.

- **pH –** A 100-ml aliquot was obtained from the thoroughly mixed sample and poured into a plastic container containing no preservative. The sample was analyzed for pH using EPA Method 150.1. The analysis was conducted as soon as possible following preparation of the flow-weighted composite sample.
- **COD –** A 100-ml aliquot was obtained from the thoroughly mixed sample and poured into a plastic containing sufficient nitric acid to reduce the pH to below 2.0. The sample was analyzed for COD using EPA Method 410.4. The holding time for the analysis is two weeks, provided the sample is refrigerated.
- **BOD –** A 500-ml aliquot was obtained from the thoroughly mixed sample, poured into a plastic container, and sealed without headspace. The holding time for this analysis is 48 hours, provided the sample is refrigerated.

3.8.11 Sampling for Dissolved Metals

The dissolved metals were analyzed using atomic absorption spectrophotometry. The water sample was poured into two 1-liter, acid–washed, plastic containers containing sufficient nitric acid preservative to reduce the pH to below 2.0. Before analysis, the sample was sealed and filtered. The holding time for the analysis is two months.

3.8.12 Sampling for Total Organic Carbon

Samples to be analyzed for total organic carbon (TOC; EPA Method 415.2) using a TOC analyzer were poured into a 100-ml glass container and sealed without headspace. Each sample was preserved with sufficient nitric acid to reduce the pH to below 2.0. The holding time for the analysis is two weeks, providing the sample is refrigerated.

3.8.13 Sampling for Suspended Solids

Water samples were analyzed for TSS (EPA Method 160.2) to evaluate the erosion rate. A 200-ml aliquot was obtained from the thoroughly mixed sample and poured into 200-ml plastic containers without preservative and refrigerated.

4.1 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

The overall objective of the QA/QC program was to implement the procedures necessary to obtain consistent, high-quality data by laboratory measurement and analysis. Generally, data quality and representativeness were assured by following approved, standardized laboratory procedures established during the previous Soil Stabilization for Temporary Slopes Study (SSTS) and ECPS studies. According to EPA guidelines, the data should be accurate, precise, and complete. Additionally, the data should have the characteristics of representativeness and comparability.

The representativeness of data was assured by following standardized measurement, sampling, and analytical procedures. Environmental measurements were made so that the results were representative of the media and the conditions being measured. A strict system of quality assurance and quality control was followed in all phases of the testing program, including sampling, laboratory analysis, and data reporting/validation.

4.2 LABORATORY QA/QC PROCEDURES

Laboratory QA/QA procedures were designed to verify that the methods used to measure the chemical constituents of interest 1) exhibit acceptable recoveries, 2) generate reproducible values, and 3) demonstrate that control samples do not contain levels of contaminants that would interfere with quantification of the constituents of concern.

Completeness of the data packages, adherence to holding times, temperature requirements, and evaluation of accuracy and precision are key components of a laboratory QA/QC program. These elements, and other described below, were checked for each laboratory report.

4.2.1 Completeness and Representativeness of the Data Package

The overall data package and individual lab reports were evaluated for completeness and representativeness of deliverables against the following criteria:

- Presence of lab reports for each sample sent
- Presence of results of all requested analyses in each lab report
- Presence of all applicable QA/QC results in each lab report
- Representative of the media and conditions being measured
- Representative of the method and instrument used

4.2.2 Holding Times

Sample collection to sample analysis holding times were calculated by computing the difference between the sample collection date and time (found on the chain-of-custody form) and the sample analysis date and time (as reported by the laboratory). Where applicable to the method, sample collection to sample extraction holding times were calculated by computing the difference between the sample collection dates and the sample preparation dates. Sample extraction to analysis holding times were calculated by computing the difference between the sample preparation dates and the sample analysis dates. Analyses that were not performed within holding-time limits were flagged and recorded in the QA/QC summary provided by the laboratory.

4.2.3 Temperature

Most analyses require that samples be kept cool for preservation. To meet this requirement, samples were placed in insulated coolers when transported to the analytical laboratory. Samples were confirmed to have met the temperature requirement at the time they were logged in at the lab.

4.3 TRAINING PROGRAM

During the SSTS (1999) and the District 7 ECPS (June 2000), workers at the SDSU/SERL participated in training sessions conducted by URS Greiner Woodward Clyde staff. Training included the proper operation and maintenance of the soil test bed, rainfall simulators, hydraulic lift devices, water-treatment system, and other laboratory equipment necessary to effect proper testing and collection of runoff and sediment samples. The focus of these training sessions was the safe use of equipment and the degree of diligence necessary to achieve consistency and accuracy of results.

Subsequent team meetings and instruction for the LCS included the following topics:

- Introduction to the project, including the goals and objectives of the study.
- Familiarization with the equipment and the importance of each device.
- Proper documentation and record keeping.
- Health and safety requirements.

Training at the laboratory facility consisted of the following activities and topics:

- Demonstrations of soil mixing and placement of soil in the test bed.
- Soil test methods for moisture content, dry density, and compaction.
- Operation of hydraulic lift system for the soil test bed.
- Operation of water treatment and supply system.
- Calibration, installation, and operation of rainfall simulators.
- Collection procedures for runoff and sediment.
- Regular servicing of equipment and recording activities in the Maintenance Log.
- Photo documentation.

4.4 OPERATION AND MAINTENANCE MANUAL

In conjunction with the training program, a manual was produced that covered the safe operation and maintenance of the equipment in the SDSU/SERL (2000), including the following:

- Rainfall simulators
- Soil test bed
- Hydraulic lift system
- Water treatment and supply system

- Soil-preparation equipment (tillers, compactors, etc.)
- Finn T-30 hydromulcher
- Analytical equipment (e.g., soil testing, scales, etc.)

The O & M Manual also included the standard operating procedures previously described.

4.5 VERIFICATION PROCEDURES

At the beginning of each test sequence, either the laboratory director or the assistant director observed the operation of each element of the testing protocol and provided any needed refinement or clarification to the established procedures. If unsafe, inaccurate, or inappropriate methods were used, the lab workers were retrained and monitored to ensure compliance.

5.1 SUMMARY OF CALTRANS TEMPORARY/PERMANENT SOIL STABILIZATION EVALUATION STUDY(TPSSES)

The following description of the Caltrans Temporary/Permanent Soil Stabilization Evaluation Study (TPSSES) was adapted from the Project Overview provided in document CTSW-RT-01-001 of March 2001.

5.2 PURPOSE OF STUDY

This Sampling and Analysis Plan (SAP) discussed the methods and procedures that were used to perform the Caltrans Temporary/Permanent Soil Stabilization Evaluation Study (the study). Consistent with the Detailed Study Plan and Experimental Design, Caltrans Soil Stabilization Study, Temporary and Permanent Soil Stabilization Measures (Study Plan), the study consisted of conducting field tests on erosion-control products selected for field application to evaluate (1) the performance of non-vegetative temporary soil stabilizers for reducing soil erosion, and (2) the potential impact of these products on storm-water quality.

5.3 GENERAL SCOPE OF ACTIVITIES

Activities consisted of selecting erosion-control products for testing, constructing test plots to evaluate selected erosion-control products, and monitoring storm-water quality during subsequent rainfall events.

5.3.1 Selection of Erosion-Control Products

Erosion-control products that were considered for testing during the study included products currently used by Caltrans construction and maintenance staff and subcontractors for stabilization of disturbed areas. Specific erosion-control products that were tested during the study were selected based on the following criteria:

- The potential for a product to impact storm-water quality (based on previous studies)
- Erosion-control effectiveness
- Installation costs
- Ease of application and cleanup
- Product availability
- Products that are currently used by Caltrans

Concurrence from Caltrans headquarters and districts was obtained before installation of the erosion-control products.

5.3.2 Construction of Test Plots

Test plots were prepared by clearing and grubbing, grading, and roughening slopes either by track walking, grid rolling, or other applicable methods. Selected erosion-control products were applied within the test plots in accordance with the appropriate specifications. Storm-water runoff from up-slope and adjacent areas was directed around and away from the test plots. Baseline plots were prepared by clearing and grubbing, grading, and roughening the slope either by track walking, grid rolling, or other applicable methods. Storm water from up-slope and adjacent areas was directed around and away from the baseline plots.

5.3.3 Storm-Water Monitoring

The storm-water monitoring effort employed automated samplers and flow meters for flow-weighted composite sample collection at selected monitoring sites. Grab samples were also collected for certain constituents at selected sites. Samples were analyzed for select constituents by state-certified laboratories for storm-water characterization.

5.3.4 Monitoring Sites

The study targets sites recently constructed or regraded, or sites where vegetative erosion-control measures are not adequately established. The project team selected sites that had relatively uniform conditions within a given site, such as soil type and slope inclination and height. Sites were selected to allow two or more products to be applied and tested concurrently (two or more adjacent test plots of similar size). Testing more than one product at a site helped to limit the variations inherent between sites, such as sunlight exposure, rain intensity, soil conditions, and others. The size of each site also accommodated a plot area without a soil stabilizer (baseline plot), if possible. This baseline plot was monitored and sampled as a control.

The objective of the statistical analysis of data from the Temporary/Permanent Soil Stabilization Evaluation Study (TPSSES) and the Laboratory Correlation Study (LCS) was to assess the consistency of soil erosion and water-quality measurements taken in the field and laboratory when seven hydraulically-applied erosion control products were applied to “fine” and “course” soil plots.

6.1 BACKGROUND SUMMARY

Seven hydraulic erosion control products were applied to soil plots at the SDSU Soil Erosion Research Laboratory and at the Orange County field sites as part of the TPSSES. They were:

1) Earth Guard™,
2) Soil Sement™,
3) Airtrol™
4) Ultra Tack™
5) Chemco™
6) Tacking Agent III™
7) Topcoat™

Bare soil control plots were also evaluated.

Plots at the SDSU indoor laboratory were subjected to simulated rainfall from 10-year storms as defined by the District 7 Erosion Control Pilot Study (ECPS) with runoff collected by the SDSU/SERL staff. Plots in the field were subjected to three natural rainstorms with runoff collected during storm events. The SDSU/SERL and the TPSSES used different methods for collecting water samples and different labs to test the water quality samples. The TPSSES produced data from the following nine treatments:

(1) Bare course soil
(2) Earth Guard™ applied on course soil
(3) Soil Sement™ applied on course soil
(4) Bare fine soil
(5) Tacking Agent III™ applied on fine soil
(6) Airtrol™ applied on fine soil
(7) Ultra Tack™ applied on fine soil
(8) Chemco™ applied on fine soil, and
(9) Topcoat™ applied on fine soil.

The TPSSES produced data during two or three different storm events. In analyzing this data, the average value of the two (or three) storm events was used to obtain one measurement for each of the nine treatments. The SDSU Soil Erosion Research Laboratory conducted experiments on the same nine treatments under two different storm events, separated by a 24 hour period. Data from these two storm events were averaged to compare to the TPSSES values using a correlation analysis.

6.2 MEASUREMENTS

The following 42 water quality measurements were gathered and stored on the Excel file "LCS Stats Data Spreadsheet Oct11"(Appendix E)

PH	***SO_4***	***Mg***
EC	***TPH***	***Na***
TSS	***NO_2***	***Ni***
TDS	***Al***	***Pb***
Hardness	***As***	***TI***
BOD	***Ba***	***V***
COD	***Ca***	***Zn, and***
DOC	***Cd***	***Respective dissolved metals from Al to Zn listed previously***
TOC	***Cr***	***Runoff Volume***
NO_3	***Cu***	***Sediment Capture***
TKN	***Fe***	***Total Rate of Sediment***
P	***Hg***	***Runoff Rate***
Othro-P	***K***	***Erosion Rate***
NH_3-N	***Li***	***Total Erosion Rate.***

All missing data and measurements not tested by both labs were omitted from the analysis. Consequently, only the following 18 water quality variables were included in the statistical analysis: *pH*, *TSS* (Total Suspended Solids), *TOC* (Total Organic Carbon), NO_3 (nitrogen), *TKN* (Total Kjedahl Nitrogen), *P* (Phosphrous), *dAs* (Dissolved Arsenic), *dCd* (Dissolved Cadmium), *dCr* (Dissolved Chromium), *dCu* (Dissolved Copper), *dFe* (Dissolved Iron), *dHg* (Dissolved Mercury), *dMg* (Dissolved Magnesium), *dNi* (Dissolved Nickel), *dPb* (Dissolved Lead), *dZn* (Dissolved Zinc), *vol* (runoff volume) and *rate* (runoff rate). *dFe, dHg, and dMg* were tested by both labs only on fine soil (not on course soil), so the number of comparable measurements is smaller for these variables. Some measurements were below the detectable limits of the laboratory, these values were replaced by one-half of the detectable limit.

6.3 RESULTS

Figures 6.1 through 6.17 provide a graphic representation of the values obtained from the Water Quality Analysis. The regression plots place the data from the TPSSES on the "y" axis and the SDSU/SERL data on the "x" axis. *Plot Size, Rainfall Amount, and Storm Duration* may influence the water-quality variables and should be included in a thorough statistical analysis; however, there was not sufficient data to determine the effects of these variables on water quality and the design of the two experiments did not allow these effects to be estimated. It appears that in particular, rainfall amounts of the two experiments were so different that water quality measurements may be due to differences in the rainfall amounts of the experiments.

The correlation of the SDSU Soil Erosion Research Laboratory and the TPSSES values were calculated for each water quality measurement separately; linear regression equations were also calculated. Table 6.1 lists the R-squared (correlation coefficient squared) for each measurement and their associated p-values. A p-value less than 0.05 indicates that the correlation of the measurements is stronger than that expected by chance. R-squared values below 25% indicate poor correlation of the field and lab data.

Only Total Suspended Solids (TSS) and Total Organic Carbon (TOC) show reasonable correlation of lab and field data with R-squared values of 52.7% and 36.5% (although the R-squared values for *dFe* and *dMg* are moderately large, these values are artificially inflated by the small number of data points available for analysis). All other water-quality measurements show poor correlation of field and lab data. Logarithmic transformations of the data were explored but did not increase the correlation of the measurements: all R-squared values remained below 25%. We will not interpret this poor correlation, but note that there were significant differences in the design, sampling methodology and laboratory testing in the field and lab experiments that may explain the poor correlation of the measurements.

Total Organic Carbon shows a moderate correlation between the lab and field measurements, although this correlation was not significantly different than what would be expected by chance. A plot of the data (Figure 1) reveals an outlier in the SERL measurements; when this data point was removed the R-squared value decreased to 10.1%.

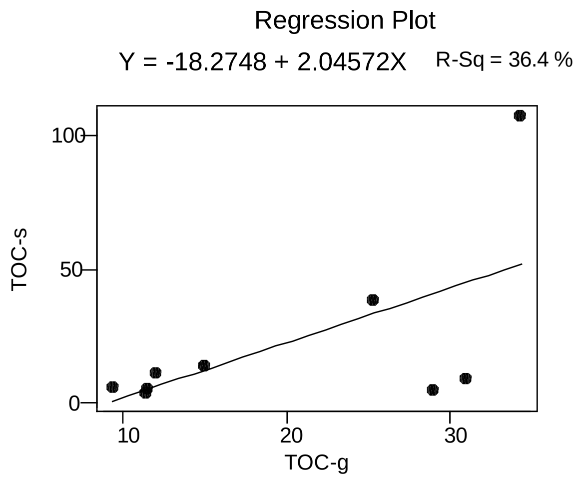
Total Suspended Solids exhibited a significant and moderately good correlation between the field and lab measurements when the data was logarithmically transformed. These measurements are displayed in Figure 2, the line y=x is displayed for ease of interpretation. In Figure 2, we see that although there is not perfect agreement of the field and lab values, there is a strong linear correlation in these values: when the lab values were high, so were the field values; when the lab values were low, so were the field values. The SERL values tended to be higher than the field values. Field values can be estimated from the lab values using the linear regression equation.

Table 6-1
Summary of Statistical Analysis of Data

Water Quality Measurements	R-squared	p-value
pH	**0.1%**	**0.936**
***TSS* (logarithmically transformed)**	**52.7%**	**0.027**
TOC	**36.5%**	**0.085**
NO_3	**9.8%**	**0.412**
TKN	**13.2%**	**0.337**
P	13.4%	**0.332**
dAs	2.5%	**0.682**
dCd	1.3%	**0.773**
dCr	9.2%	**0.428**
dCu	4.6%	**0.581**
dFe	58.7%*	**0.444**
dHg	**	
dMg	72.6%*	**0.350**
dNi	2.4%	**0.691**
dPb	1.6%	**0.747**
dZn	2.3%	**0.699**
vol	1.0%	**0.812**
rate	1.7%	**0.760**

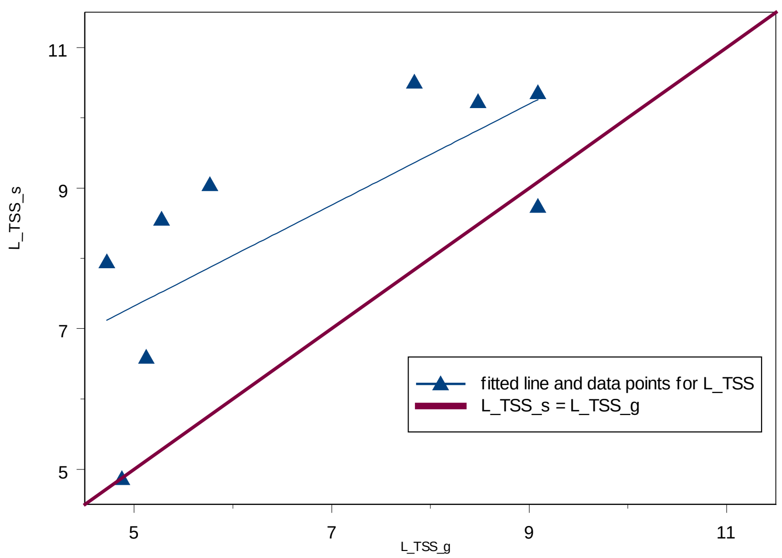
*** Only 3 data points.***
***** same values for SERL –not able to fit a regression line.***

Figure 6.1:
Estimated Linear Equation for TOC



The regression equation is:
$y = -18.3 + 2.05\,x$ with $R^2 = 36.4\%$.
36.4% of the variation of TOC-s is accounted for by the model.

Figure 6.2:
Estimated Linear Equation for TSS

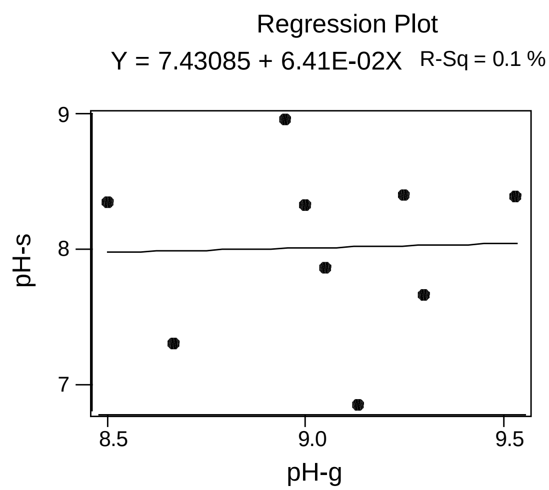


The regression equation is:
$y = 3.73 + 0.719\,x$ with $R^2 = 52.7\%$
for the logarithmically-transformed data.

52.7% of the variation of L-TSS-s is accounted for in the model.

Figure 6.3:

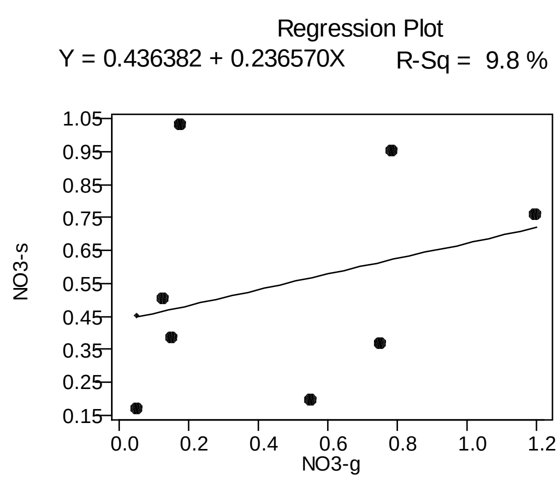
Estimated Linear Equation for pH



The regression equation is:
$y = 7.43 + 0.064x$ with $R^2 = 0.1\%$

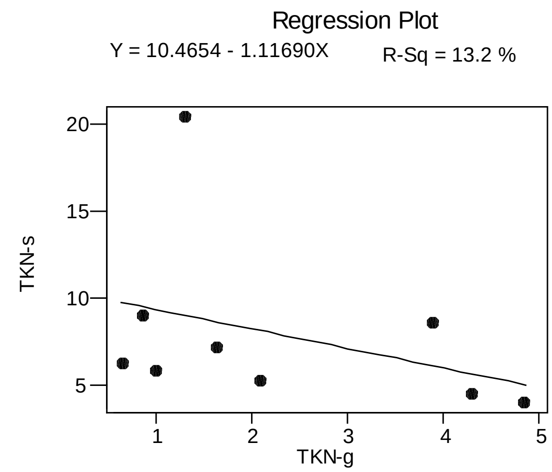
Figure 6.4:

Estimated Linear Equation for NO_3



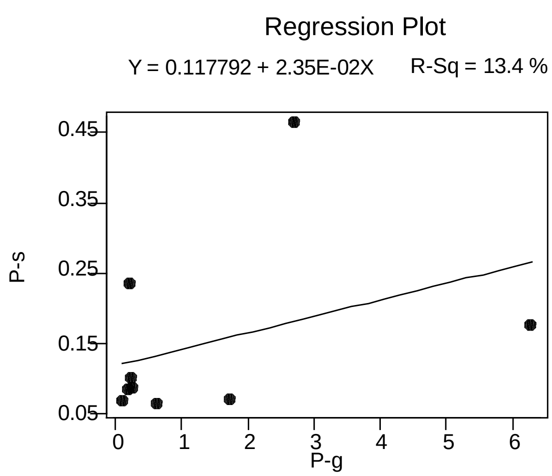
The regression equation is:
$y = 0.436 + 0.237x$ with $R^2 = 9.8\%$.

Figure 6.5:
Estimated Linear Equation for TKN



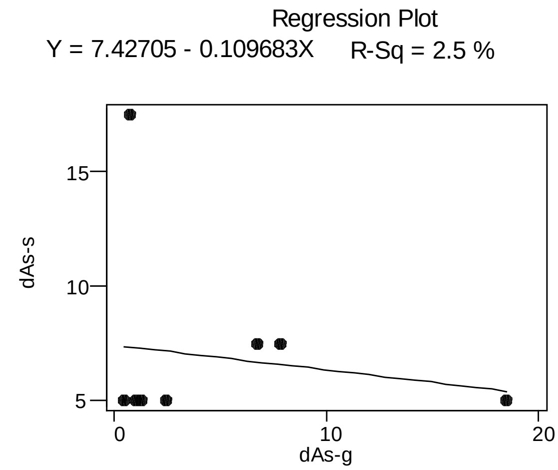
The regression equation is:
$y = 10.5 - 1.12\ x$ with $R^2 = 13.2\%$.

Figure 6.6:
Estimated Linear Equation for P



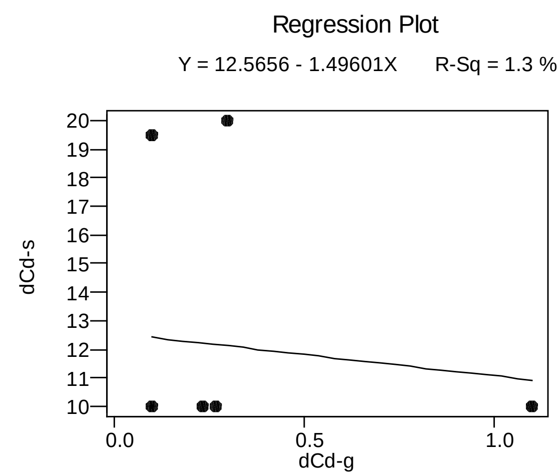
The regression equation is:
$y = 0.118 + 0.0235\ x$ with $R^2 = 13.4\%$.

Figure 6.7:
Estimated Linear Equation for dAs



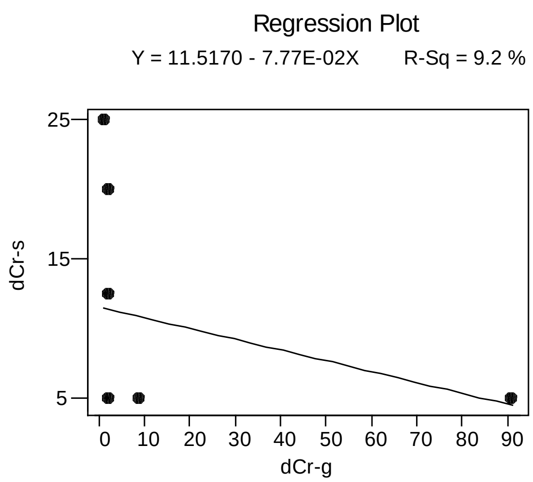
The regression equation is:
$y = 7.43 - 0.110\ x$ with R^2=2.5%.

Figure 6.8:
Estimated Linear Equation for dCd



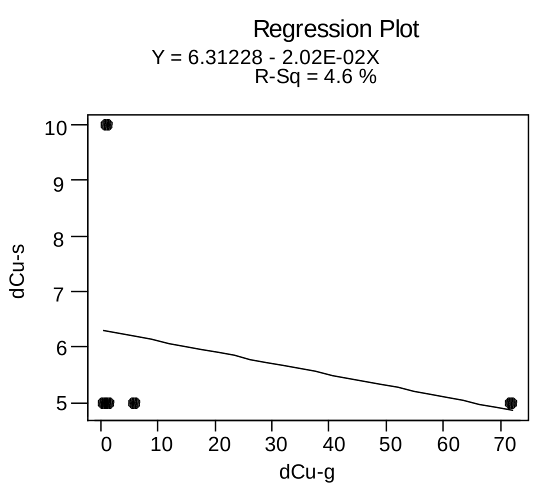
The regression equation is:
$y = 12.6 - 1.50\ x$ with R^2 = 1.3%.

Figure 6.9:
Estimated Linear Equation for dCr



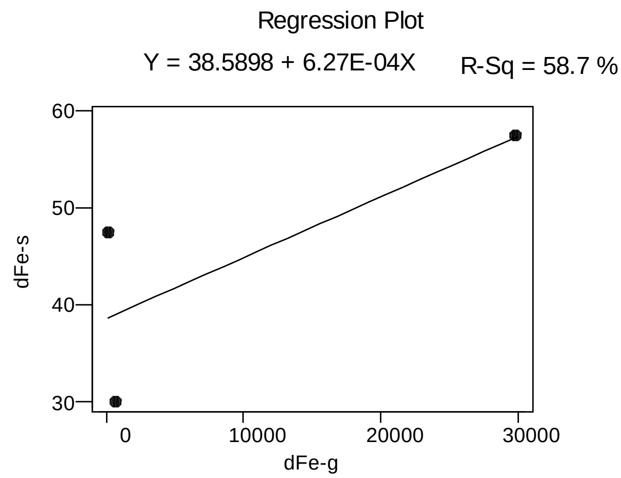
The regression equation is:
y = 11.5 - 0.0777 x with R^2= 9.2%.

Figure 6.10:
Estimated Linear Equation for dCu



The regression equation is:
y = 6.31 - 0.0202 x with R^2= 4.6%.

Figure 6.11:
Estimated Linear Equation for dFe



The regression equation is:
y = 38.6 +0.000627 x with R^2 = 58.7%.

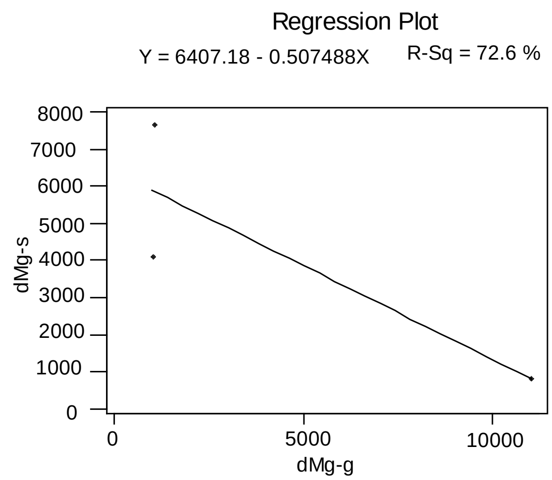
Although the R-squared values is high, the line was fitted to only three data points. The correlation is not significantly higher than what would be expected by chance.

Estimated Linear Equation for dHg

Because all the data points obtained from Soil Lab were identical in values, it was not possible to calculate a correlation coefficient or a regression line for this variable.

Figure 6.12:

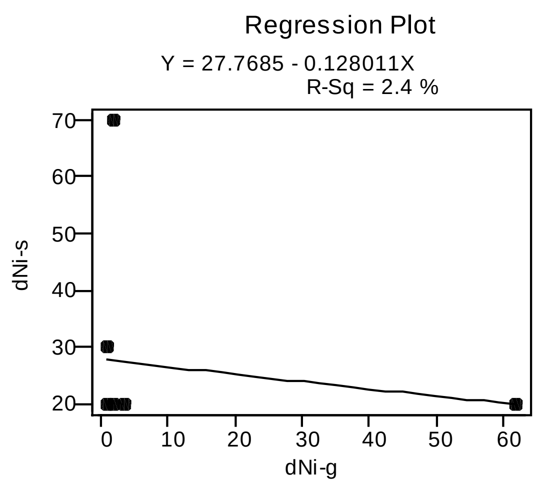
Estimated Linear Equation for dMg



The regression equation is:
y = 6407 - 0.507 x with R^2= 72.6%.

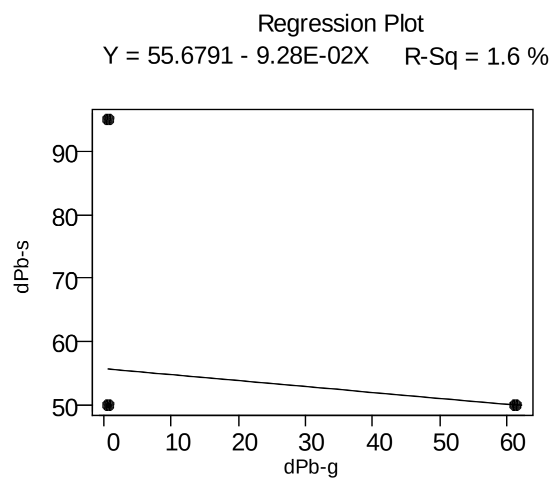
Although the R-squared values is high, the line was fitted to only three data points. The correlation is not significantly higher than what would be expected by chance.

Figure 6.13:
Estimated Linear Equation for dNi



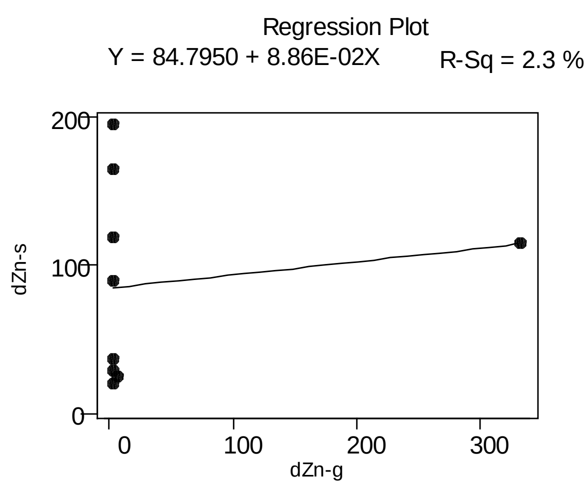
The regression equation is:
y = 27.8 - 0.128 x with R^2= 2.4%.

Figure 6.14:
Estimated Linear Equation for dPb



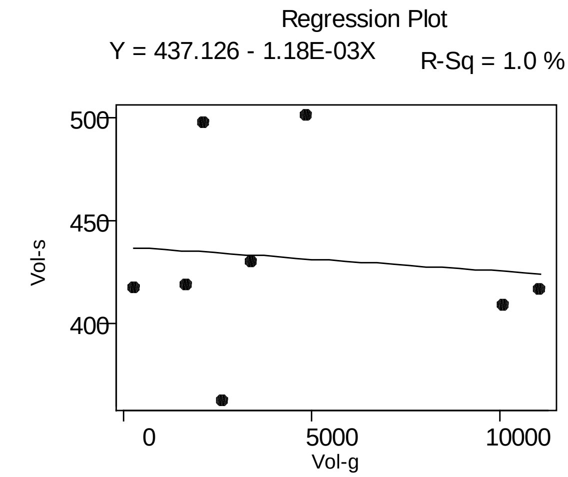
The regression equation is:
y = 55.7 - 0.093 x with R^2= 1.6%.

Figure 6.15:
Estimated Linear Equation for dZn



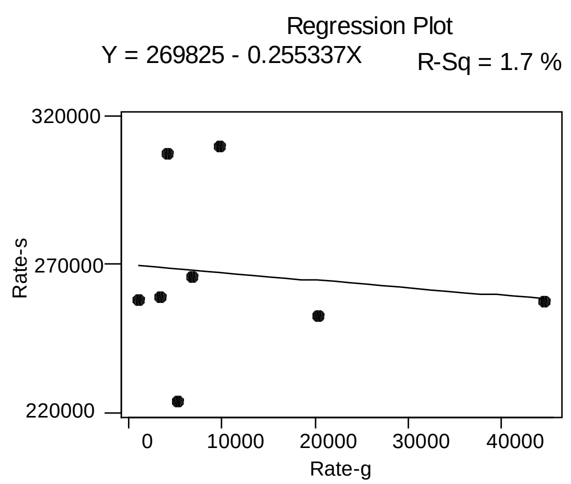
The regression equation is:
y = 84.8 + 0.089 x with R^2= 2.3%.

Figure 6.16:
Estimated Linear Equation for Volume



The regression equation is:
$y = 437 - 0.00118\ x$ with $R^2 = 1.0\%$.

Figure 6.17:
Estimated Linear Equation for Runoff Rate



The regression equation is:
$y = 269825 - 0.255\ x$ with $R^2 = 1.7\%$.

Note: one missing value from TPSSES from bare course soil.

7.1 GOALS AND OBJECTIVES OF THE STUDY

The primary objective of the Laboratory Correlation Study (LCS) was to assess the consistency of soil erosion and water-quality measurements taken in the field and laboratory when seven hydraulically-applied erosion control products were applied to "fine" and "course" soil plots. These seven hydraulic erosion control products were:

1) Earth Guard™,
2) Soil Sement™
3) Airtrol™
4) Ultra Tack™
5) Chemco™
6) Tacking Agent III™
7) Topcoat™

A secondary project goal – if a correlation between field and laboratory studies was established - was to use erosion control performance and water quality data to make statewide recommendations on specification and use of the hydraulic practices that were tested.

7.2 PRIMARY GOAL: FIELD AND LABORATORY CORRELATION

During initial scoping discussions with Caltrans, the SDSU study team expressed concerns that the differences in study design between the Temporary/Permanent Soil Stabilization Evaluation Study (TPSSES) and the normal SDSU Soil Erosion Research Laboratory procedures might have an adverse effect on establishing a relationship between field and laboratory results. These differences included:

<u>TPSSES</u>	<u>SDSU/SERL</u>
Data obtained from 2-3 storm events	Data obtained from 2 consecutive storm events
Ambient storms of low intensity	10-year storms evaluated (per ECPS)
Test plot size 1/10 acre	Test plot size .004 acre
Runoff collected by sequential samplers	Sequential samplers not used – all runoff and sediment collected and analyzed
Application methods variable	Standardized hydraulic application methods

Additionally, once the actual data from the TPSSES was received, concerns were raised as to whether or not enough data was collected during the field study to compare with data that might be obtained from the indoor laboratory work. Gaps in the field data collection occurred due to failure of the sequential samplers during storm events and the fact that all hydraulic materials were not applied at the same time (e.g. at the beginning of the rainy season) and as a result, runoff from all winter storms was not collected for all products.

As a consequence, all missing data and measurements not tested by both labs were omitted from comparison and only the 18 water quality variables were included in the statistical analysis (Appendix E).

7.3 RESULTS

Plot size, rainfall amount and storm duration may influence water-quality variables and should be included in a thorough statistical analysis. However, there was not sufficient data to determine the effects of these variables on water quality and the design of the two experiments did not allow these effects to be estimated. It appears that in particular, rainfall amounts of the two experiments were so different that water quality measurements may be due to differences in the rainfall amounts of the experiments.

Table 6.1 lists the R-squared (correlation coefficient squared) for each measurement and their associated p-values:

- *A p-value less than 0.05 indicates that the correlation of the measurements is stronger than that expected by chance.*
- *R-squared values below 25% indicate poor correlation of the field and lab data.*

The correlation of the SDSU Soil Erosion Research Laboratory and the TPSSES values were calculated for each water quality measurement separately; linear regression equations were also calculated:

6) Only total suspended solids (TSS) and total organic carbon (TOC) show reasonable correlation of lab and field data with R-squared values of 52.7% and 36.5%
7) Although the R-squared values for *dFe* and *dMg* are moderately large, these values are artificially inflated by the small number of data points available for analysis
8) Logarithmic transformations of the data were explored but did not increase the correlation of the measurements: all R-squared values remained below 25%.
9) Total Suspended Solids exhibited a significant and moderately good correlation between the field and lab measurements when the data was logarithmically transformed. Although there is not perfect agreement of the field and lab values, there is a strong linear correlation in these values (e.g., when the lab values were

high, so were the field values; when the lab values were low, so were the field values).

10) All other water-quality measurements show poor correlation of field and lab data.

The SDSU study team interpreted this poor correlation to be primarily due to the significant differences in the design, sampling methodology and laboratory testing in the field and lab experiments.

7.4 SECONDARY GOAL: SPECIFICATION AND USAGE RECOMMENDATIONS

Past Caltrans studies – e.g., the District 7 Erosion Control Pilot Study (ECPS, 2000) and the Soil Stabilization for Temporary Slopes Study (SSTS, 1999) – and numerous privately-commissioned tests at the SDSU Soil Erosion Research Laboratory have established both the erosion control effectiveness and water quality impacts of various hydraulically-applied soil stabilizers. Most of the products tested in the past have demonstrated a high level of erosion control effectiveness, ranging from 65-95% reduction in off-site sediment delivery. Additionally, most of the tested materials demonstrated little adverse water quality impact.

A common expectation has been that a high level of performance at the SDSU/SERL probably equated to a high level of performance in the field. However, a direct correlation between indoor laboratory performance and field performance – a relationship that some specifiers or designers might require to approve material usage - was not established as a result of this study. As previously stated, the SDSU study team considers the differences in study design and data collection procedures to account for the apparent lack of correlation.

It is therefor the study team's recommendation that any future studies that attempt to establish a correlation between field and laboratory performance of erosion control materials should duplicate, to the extent practical:

- Soil conditions
- Slope preparation procedures
- Slope length and steepness
- Product application procedures
- Plot size
- Data collection procedures
- Rainfall events

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Statistical Appendix

Results of the fitted equation for pH

The regression equation is y = 7.43 + 0.064 x

Predictor	Coef	StDev	T	P
Constant	7.431	7.019	1.06	0.325
x	0.0641	0.7758	0.08	0.936

S = 0.6958 R-Sq = 0.1% R-Sq(adj) = 0.0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	0.0033	0.0033	0.01	0.936
Residual Error	7	3.3893	0.4842		
Total	8	3.3926			

Results of the fitted equation for TSS(in log)

The regression equation is y = 3.73 + 0.719 x

Predictor	Coef	StDev	T	P
Constant	3.727	1.782	2.09	0.075
x	0.7187	0.2572	2.79	0.027

S = 1.373 R-Sq = 52.7% R-Sq(adj) = 46.0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	14.719	14.719	7.81	0.027
Residual Error	7	13.194	1.885		
Total	8	27.913			
3.3926					

Results of the fitted equation for TOC

The regression equation is y = - 18.3 + 2.05 x

Predictor	Coef	StDev	T	P
Constant	-18.27	22.42	-0.82	0.442
x	2.046	1.021	2.00	0.085

S = 28.59 R-Sq = 36.4% R-Sq(adj) = 27.4%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	3282.6	3282.6	4.01	0.085
Residual Error	7	5723.3	817.6		
Total	8	9005.9			

Results of the fitted equation for NO_3

The regression equation is y = 0.436 + 0.237 x

Predictor	Coef	StDev	T	P
Constant	0.4364	0.1563	2.79	0.027
x	0.2366	0.2711	0.87	0.412

S = 0.3162 R-Sq = 9.8% R-Sq(adj) = 0.0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	0.07609	0.07609	0.76	0.412
Residual Error	7	0.69972	0.09996		
Total	8	0.77581			

Results of the fitted equation for TKN

The regression equation is y = 10.5 - 1.12 x

Predictor	Coef	StDev	T	P
Constant	10.465	2.981	3.51	0.010
x	-1.117	1.083	-1.03	0.337

S = 4.966 R-Sq = 13.2% R-Sq(adj) = 0.8%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	26.21	26.21	1.06	0.337
Residual Error	7	172.63	24.66		
Total	8	198.84			

Results of the fitted equation for P

The regression equation is y = 0.118 + 0.0235 x

Predictor	Coef	StDev	T	P
Constant	0.11779	0.05344	2.20	0.063
x	0.02349	0.02256	1.04	0.332

S = 0.1308 R-Sq = 13.4% R-Sq(adj) = 1.0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	0.01854	0.01854	1.08	0.332
Residual Error	7	0.11970	0.01710		
Total	8	0.13824			

Results of the fitted equation for dAs

The regression equation is y = 7.43 - 0.110 x

Predictor	Coef	StDev	T	P
Constant	7.427	1.833	4.05	0.005
x	-0.1097	0.2568	-0.43	0.682

S = 4.331 R-Sq = 2.5% R-Sq(adj) = 0.0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	3.42	3.42	0.18	0.682
Residual Error	7	131.30	18.76		
Total	8	134.72			

Results of the fitted equation for dCd

The regression equation is y = 12.6 - 1.50 x

Predictor	Coef	StDev	T	P
Constant	12.566	2.024	6.21	0.000
x	-1.496	4.998	-0.30	0.773

S = 4.569 R-Sq = 1.3% R-Sq(adj) = 0.0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	1.87	1.87	0.09	0.773
Residual Error	7	146.13	20.88		
Total	8	148.00			

Results of the fitted equation for dCr

The regression equation is y = 11.5 - 0.0777 x

Predictor	Coef	StDev	T	P
Constant	11.517	2.816	4.09	0.005
x	-0.07770	0.09232	-0.84	0.428

S = 7.723 R-Sq = 9.2% R-Sq(adj) = 0.0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	42.24	42.24	0.71	0.428
Residual Error	7	417.48	59.64		
Total	8	459.72			

Results of the fitted equation for dCu

The regression equation is y = 6.31 - 0.0202 x

Predictor	Coef	StDev	T	P
Constant	6.3123	0.8426	7.49	0.000
x	-0.02017	0.03486	-0.58	0.581

S = 2.303 R-Sq = 4.6% R-Sq(adj) = 0.0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	1.775	1.775	0.33	0.581
Residual Error	7	37.114	5.302		
Total	8	38.889			

Results of the fitted equation for dFe

The regression equation is y = 38.6 +0.000627 x

Predictor	Coef	StDev	T	P
Constant	38.590	9.063	4.26	0.147
x	0.0006269	0.0005253	1.19	0.444

S = 12.64 R-Sq = 58.7% R-Sq(adj) = 17.5%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	227.6	227.6	1.42	0.444
Residual Error	1	159.9	159.9		
Total	2	387.5			

Results of the fitted equation for dMg

The regression equation is y = 6407 - 0.507 x

Predictor	Coef	StDev	T	P
Constant	6407	2001	3.20	0.193
x	-0.5075	0.3115	-1.63	0.350

S = 2540 R-Sq = 72.6% R-Sq(adj) = 45.3%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	17124210	17124210	2.65	0.350
Residual Error	1	6451607	6451607		
Total	2	23575817			

Results of the fitted equation for dNi

The regression equation is y = 27.8 - 0.128 x

Predictor	Coef	StDev	T	P
Constant	27.769	6.415	4.33	0.003
x	-0.1280	0.3089	-0.41	0.691

S = 17.51 R-Sq = 2.4% R-Sq(adj) = 0.0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	52.7	52.7	0.17	0.691
Residual Error	7	2147.3	306.8		
Total	8	2200.0			

Results of the fitted equation for dPb

The regression equation is y = 55.7 - 0.093 x

Predictor	Coef	StDev	T	P
Constant	55.679	5.676	9.81	0.000
x	-0.0928	0.2768	-0.34	0.747

S = 15.91 R-Sq = 1.6% R-Sq(adj) = 0.0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	28.5	28.5	0.11	0.747
Residual Error	7	1771.5	253.1		
Total	8	1800.0			

Results of the fitted equation for dZn

The regression equation is y = 84.8 + 0.089 x

Predictor	Coef	StDev	T	P
Constant	84.79	24.53	3.46	0.011
x	0.0886	0.2203	0.40	0.699

S = 68.71 R-Sq = 2.3% R-Sq(adj) = 0.0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	764	764	0.16	0.699
Residual Error	7	33044	4721		
Total	**8**	**33808**			

Results of the fitted equation for vol

The regression equation is y = 437 - 0.00118 x

8 cases used - 1 case is a missing value

Predictor	Coef	StDev	T	P
Constant	437.13	27.62	15.83	0.000
x	-0.001176	0.004729	-0.25	0.812

S = 49.83 R-Sq = 1.0% R-Sq(adj) = 0.0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	154	154	0.06	0.812
Residual Error	6	14897	2483		
Total	7	15051			

Results of the fitted equation for rate

The regression equation is y = 269825 - 0.255 x

8 cases used - 1 cases is a missing value

Predictor	Coef	StDev	T	P
Constant	269825	14458	18.66	0.000
x	-0.2553	0.7991	-0.32	0.760

S = 30680 R-Sq = 1.7% R-Sq(adj) = 0.0%

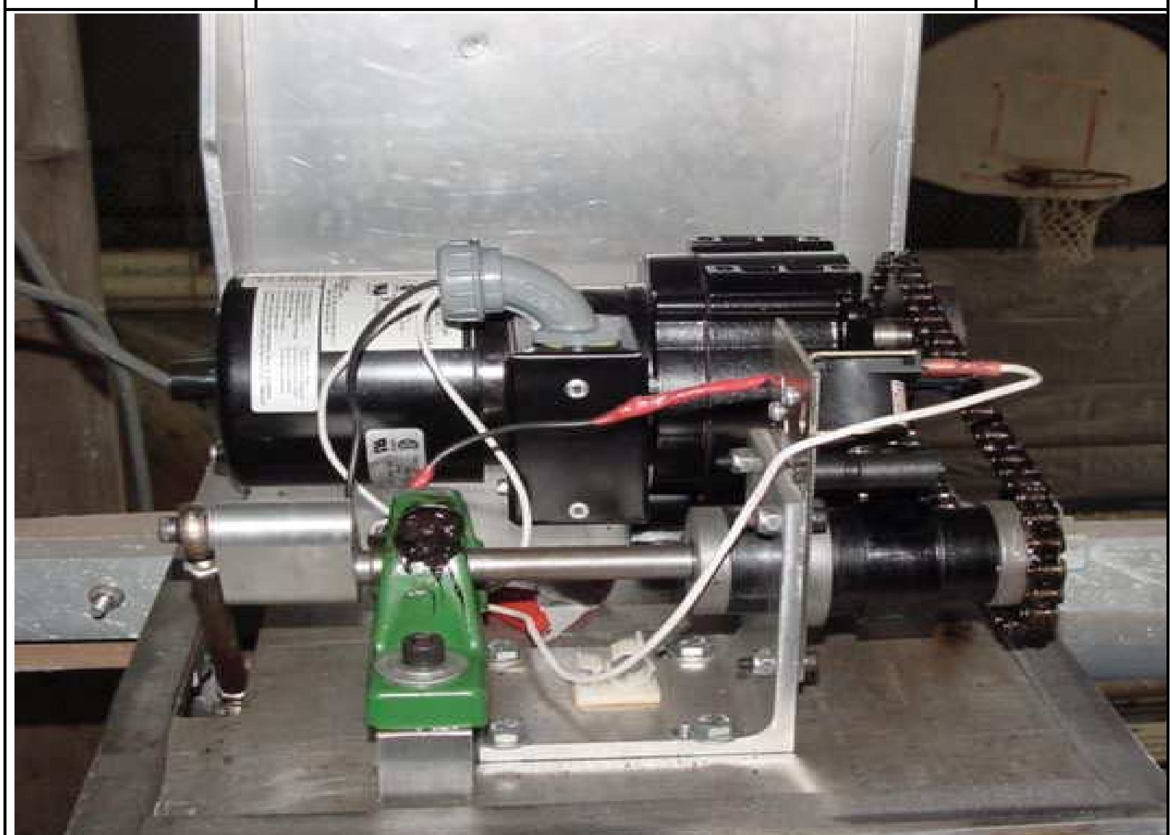
Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	96108022	96108022	0.10	0.760
Residual Error	6	5647622961	941270493		
Total	7	5743730983			

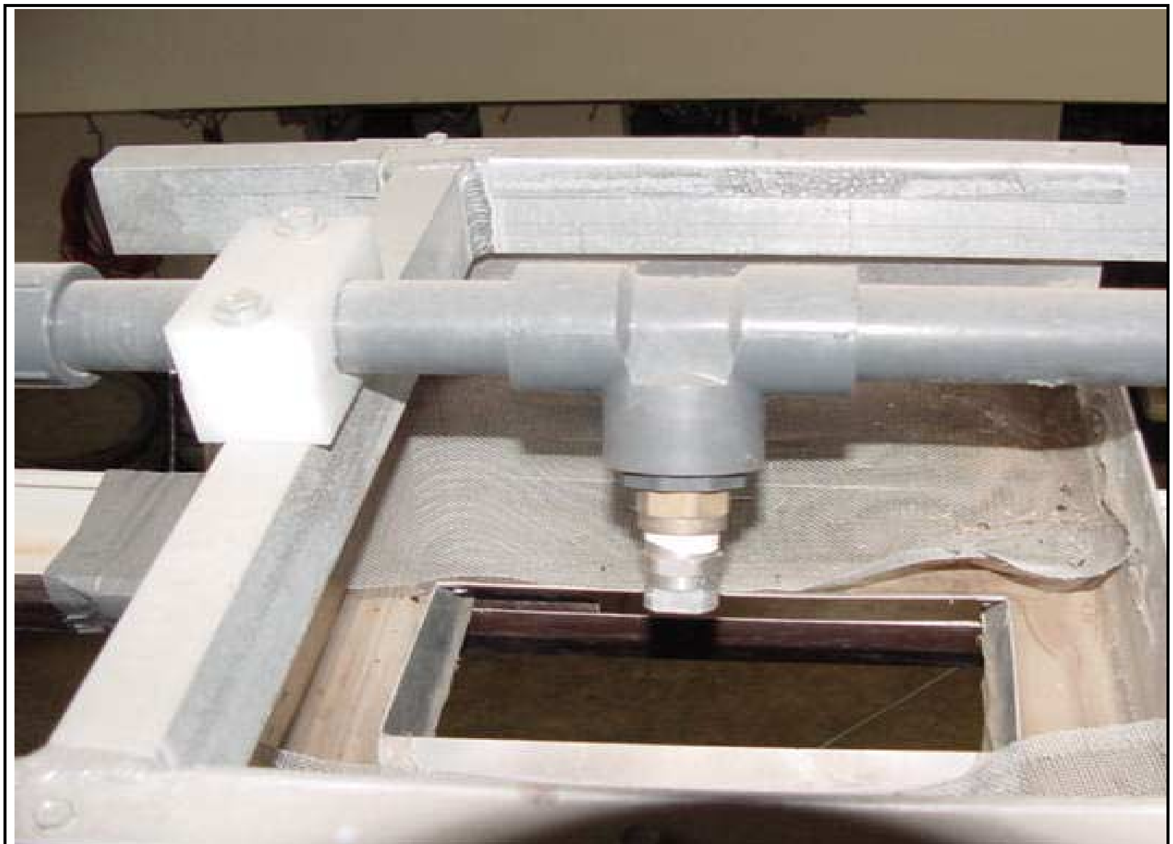
Report Date: June 2002	San Diego State University Soil Erosion Research Laboratory	Fig.: 1

Report Date: June 2002	Norton Ladder Rainfalll Simulator	Fig.: 2

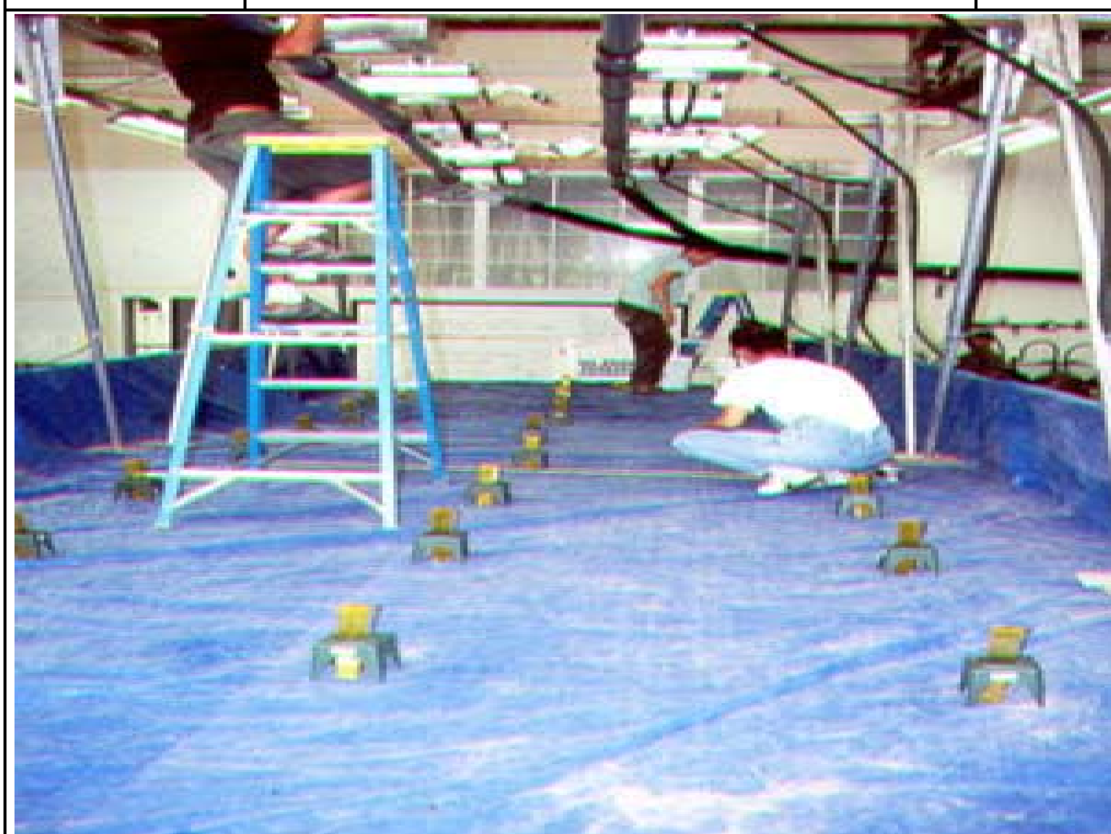
Report Date: June 2002	Parallel installation of simulators above soil test bed	Fig.: 3



Report Date: June 2002	Electrical drive unit for rainfall simulator	Fig.: 4

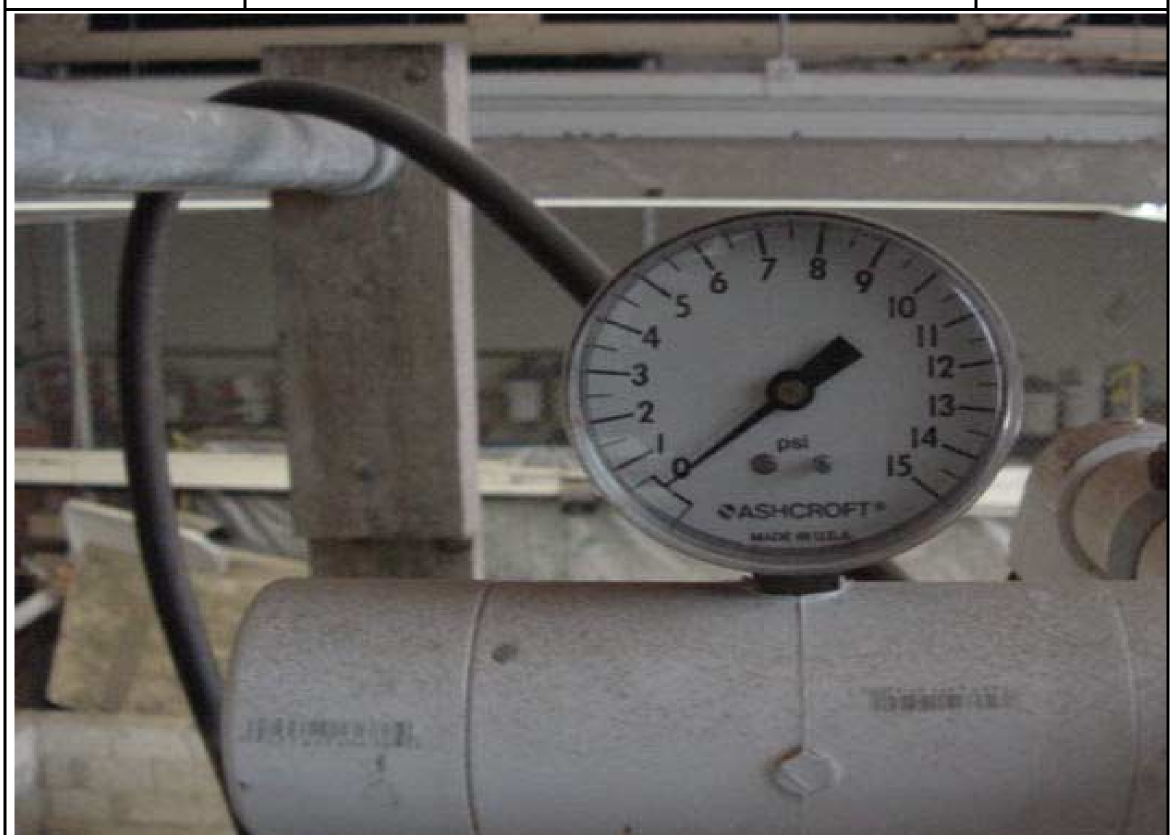


Report Date: June 2002	Veejet 80100 nozzle positioned over sump box	Fig.: 5

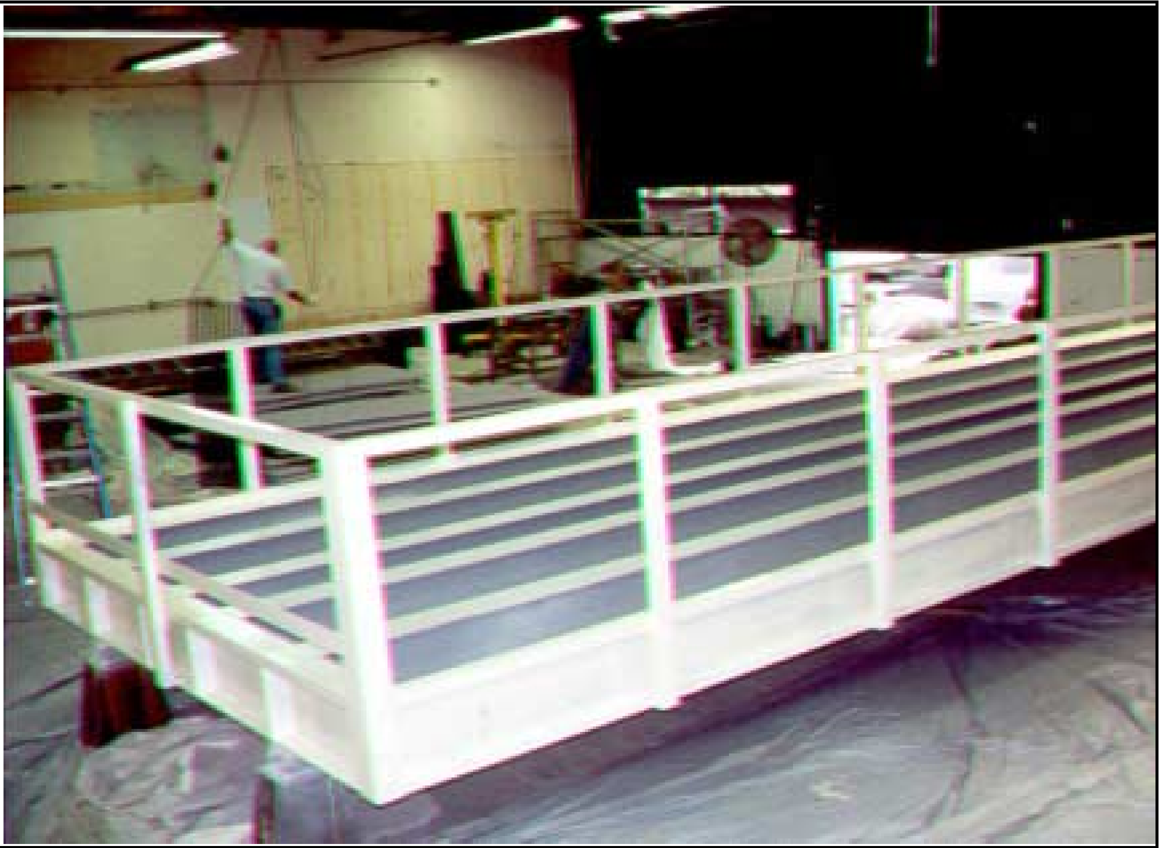


Report Date: June 2002	Placement of collection devices during calibration of rainfall simulators	Fig.: 6

Report Date: June 2002 | Electronic control box manipulates sweeps per minute | Fig.: 7



Report Date: June 2002 | Water pressure gauge atop rainfall simulator | Fig.: 8

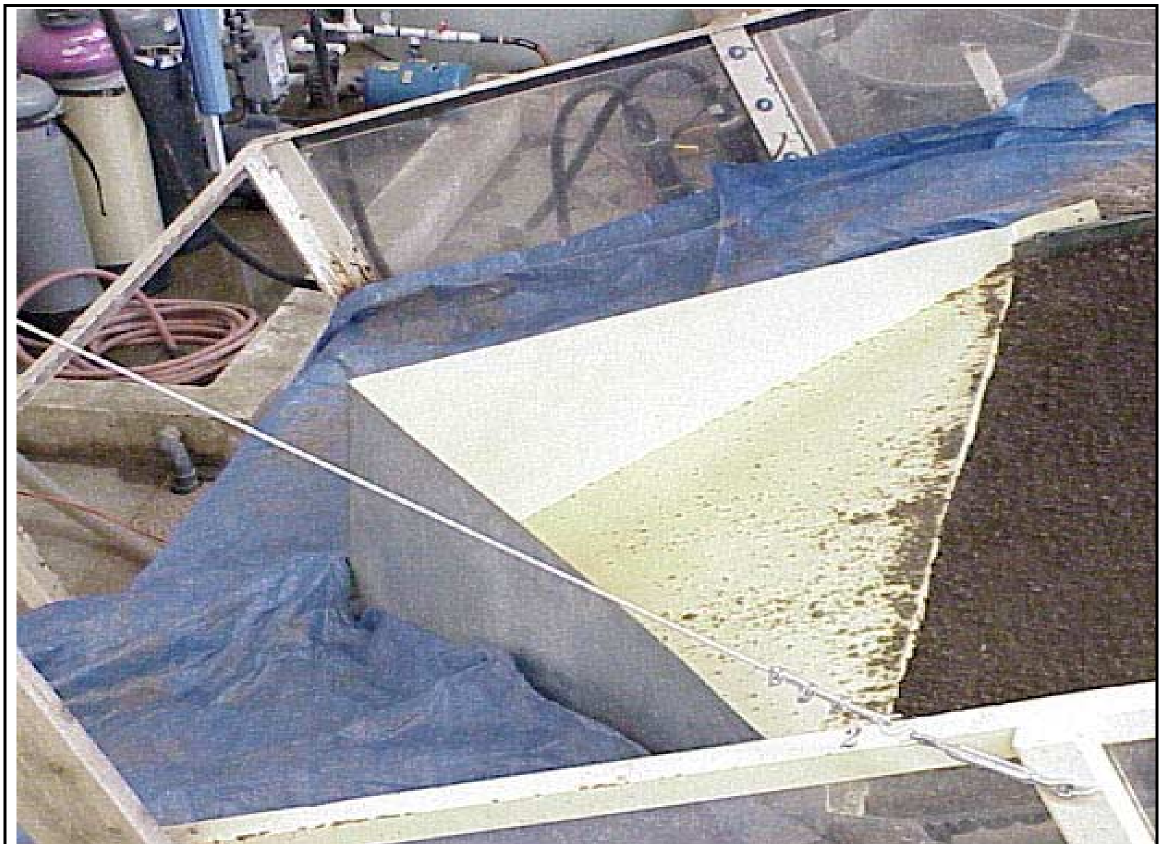


Report Date: June 2002	Soil test bed under construction, illustration I-beam construction	Fig.: 9

Report Date: June 2002	Soil test bed raised to a 1V:2H slope, exposing five-stage hydraulic cylinders and steel safety supports	Fig.:10

Report Date: June 2002	Framework and Plexiglas sides of test bed	Fig.: 11

Report Date: June 2002	Test bed, illustrating plastic edging used to define 2 meter x 8 meter test bed	Fig.: 12



Report Date: June 2002	Metal collection flume at end of test bed	Fig.: 13

Report Date: June 2002	Hydraulic system for lifting test bed	Fig.: 14

Report Date: June 2002	Collection of runoff and sediment during rainfall simulation	Fig.: 15

Report Date: June 2002	Water treatment system	Fig.: 16

Report Date: June 2002	Water return system directs unused water to storage tank	Fig.: 17

Report Date: June 2002	1,000 gallon storage tank	Fig.: 18

Report Date: June 2002	Test soil storage bin inside laboratory	Fig.: 19

Report Date: June 2002	Placement of soil in test bed	Fig.: 20

Report Date: June 2002	Conducting sand cone tests on newly-placed soil	Fig.: 21

Report Date: June 2002	Excavation of 2 meter x 8 meter plot to replace soil type	Fig.: 22

Report Date: June 2002	Compaction of new soil in excavated area	Fig.: 23

Report Date: June 2002	Removal of wetted soil from previous testing	Fig.: 24

Report Date: June 2002	Placement of new, untested soil in test bed	Fig.: 25

Report Date: June 2002	Installing edging and flume to differentiate a 2 meter x 8 meter plot	Fig.: 26

Report Date: June 2002	Hydraulic application of test material	Fig.: 27

Report Date: June 2002	Finn T30, 300 gallon hydroseeder	Fig.: 28

Report Date: June 2002	Mixing the binder and mulch prior to application	Fig.: 29

Report Date: June 2002	Calibration for the application time	Fig.: 30

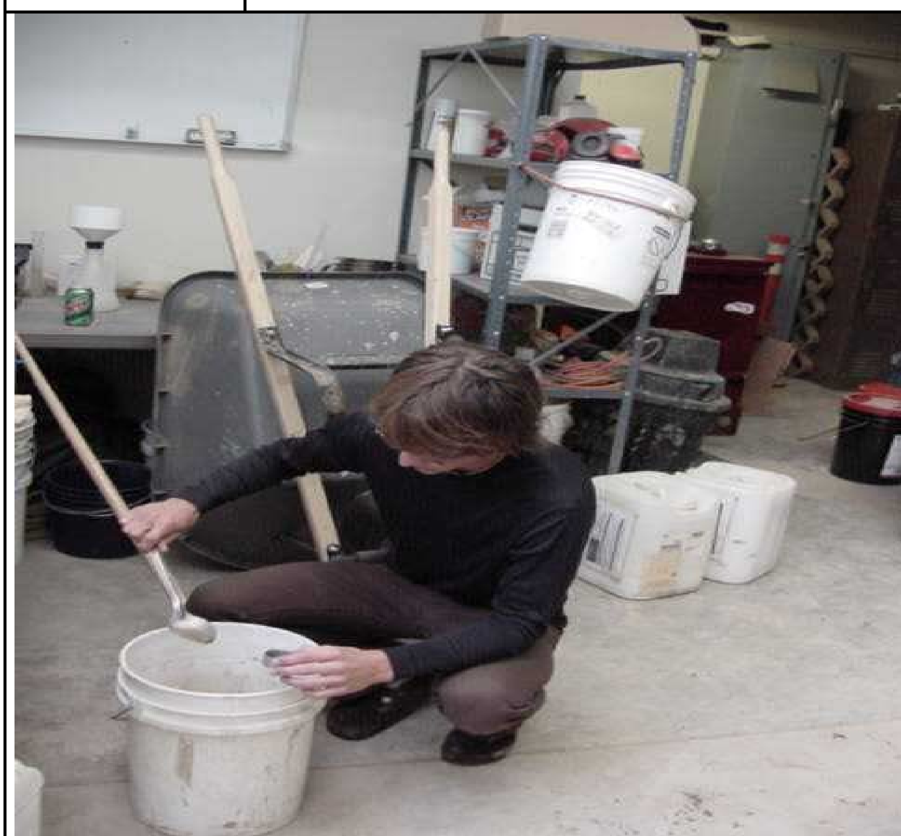
Report Date: June 2002	Applying the hydraulic mixture to the soil test bed	Fig.: 31

Report Date: June 2002	Completed application of hydraulic material	Fig.: 32

Report Date: June 2002	Thirty-five gallon collection container	Fig.: 33

Report Date: June 2002	Adding 500 grams of gypsum for flocculation	Fig.: 34

Report Date: June 2002	Decanting the clear water (supernatant)	Fig.: 35



Report Date: June 2002	Collecting the wet sediment sample	Fig.: 36

Report Date: June 2002	Oven-drying of wet sediment sample	Fig.: 37

Report Date: June 2002	Collecting a grab sample for water quality analysis	Fig.: 38

Report Date: June 2002	Water quality samples from test prepared for shipment and analysis	Fig.: 39